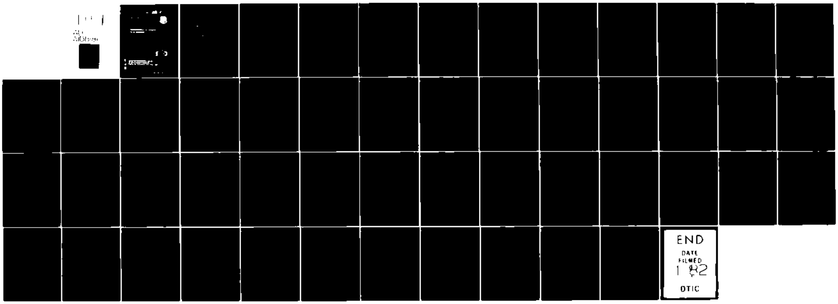
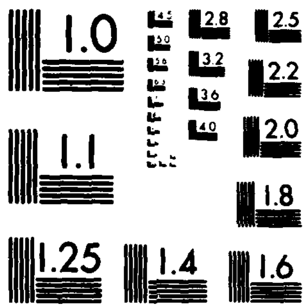
AD-A108 181 ROME AIR DEVELOPMENT CENTER GRIFFISS AFB NY F/G 9/1
MEASUREMENTS OF ANTENNA PULSE RESPONSE.(U)
JUL 81 P R CARON
UNCLASSIFIED RADC-TR-81-224 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

[illegible]

[illegible]

APPROVED: [illegible signature]

JOHN K. [illegible], Chief
Antennas & [illegible]
Electromagnetic [illegible]

APPROVED: [illegible signature]

ALLAN C. SCHELL,
Chief, Electromagnetic [illegible]

FOR THE COMMANDER: [illegible signature]

[illegible]
[illegible]

[illegible]

[illegible]

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RADC-TR-81-224	2. GOVT ACCESSION NO. AD-A108 181	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MEASUREMENTS OF ANTENNA PULSE RESPONSE		5. TYPE OF REPORT & PERIOD COVERED In-House 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Paul R. Caron*		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Deputy for Electronic Technology (EEAA) Hanscom Air Force Base Massachusetts 01731		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62702F 46001401
11. CONTROLLING OFFICE NAME AND ADDRESS Deputy for Electronic Technology (EEAA) Hanscom Air Force Base Massachusetts 01731		12. REPORT DATE July 1981 13. NUMBER OF PAGES 50
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

*Dr. Caron was assigned to RADC/EEA as a RADC Post doctoral under Contract F30602-78-C-0148, Southeastern Massachusetts University.
RADC Project Engineer: Robert J. Mailloux, EEAA

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Antenna measurements
Network analyzer
Antenna

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A technique for obtaining the pulse response of antennas utilizing steady-state measurements on a Scientific-Atlanta 2020 antenna range is described. The method involves making wideband frequency measurements, both amplitude and phase, centered about the defined carrier frequency and transforming the data to low frequency. This result is multiplied by the complex Fourier Transform of a pulse (the modulating pulse) utilizing Fast-Fourier-Transforms and the inverse FFT yields the desired pulse response. All computations are done on the 2020 System Computer (Hp 21 MX Series 1000).

DD FORM 1 JAN 73 1473

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

1

3: /C-D

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

20. Abstract (Continued)

Techniques for eliminating the frequency response of system components are described. The technique essentially treats the antenna on a "transfer function" basis. Therefore, results are presented on the response of a transmission line system and this is compared with theory. Finally, results on the pulse response of various antennas are presented.

Preface

The author wishes to express his appreciation to Dr. Robert Mailloux and Mr. John Strom for their suggestions, interest, and encouragement throughout the course of this work. The help of Mr. John Van Bobo with the experimental apparatus is also acknowledged.

Contents

Illustrations

Illustrations

Measurements of Antenna Pulse Response

1. INTRODUCTION

The objective of the work described in the paper is to obtain the pulse response of antennas. This is accomplished by measuring the steady-state response as a function of frequency, transforming to low frequency, multiplying this transfer function by the Fourier Transform of a pulse and obtaining the inverse transform of the result.

Figure 1 is a schematic representation of the measurement scheme. A Scientific-Atlanta 2020 Antenna Analyzer System is used to make the measurements. The data gathering as well as the analysis is done by the computer-controlled 2020 system. The system software was designed in accordance with Scientific-Atlanta Protocol and is divided into three sections: 1) A test file generator section that obtains information from the operator about the parameters (that is, position, carrier frequency, time resolution, etc.) for the measurement and analysis (Figure 2 is a typical listing of a test file), 2) A data acquisition section that acquires data and stores it in a data file on disk, and, 3) A data analysis section that retrieves the information from the data file, does the Fourier Analysis, and displays the results.

(Received for publication 30 July 1981)

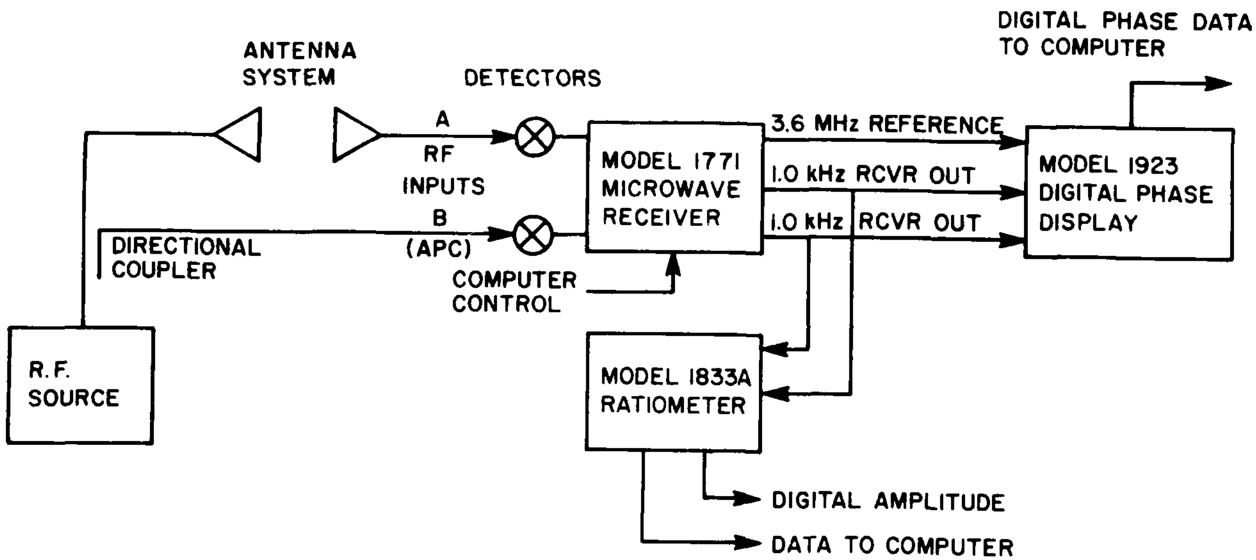


Figure 1. Schematic Representation of Measurement Technique

```
*PULSE RESPONSE      TEST FILE NR:10
     1.  POSITION
         NO POSITION DATA
     2.  FREQUENCY VALUES:
         CARRIER FREQ = 3000.00
         FREQ INC = 2.00
         NR FREQ = 512
         ACTUAL RESOLUTION TIME = .98 NANOSEC
         START FREQ = 2488.00
         END FREQ = 3510.00
     3.  RECEIVER SETUP
             DUAL MODE
             CRYSTAL CURRENT IS PRESET
             WIDE SEARCH
     4.  ANALYSIS
         ON LINE ANALYSIS WILL BE DONE
         FREQ DATA WILL NOT BE OUTPUT
         OUTPUT TO PRINTER
         SYSTEM VALUES WILL NOT BE SUBTRACTED
         NORMALIZE TO CARRIER
***END OF TEST FILE***
```

Figure 2. Typical Test File

2. FOURIER ANALYSIS

Consider an ideal pulse p(t) amplitude modulating a carrier at radian frequency w_c,

$$f(t) = p(t) \cos w_c t \ .$$

The Fourier transform is

$$F(w) = 1/2\ \underline{P}(w + w_c) + 1/2\ \underline{P}(w - w_c) \ ,$$

where $\underline{P}(w)$ is the Fourier transform of p(t). If this is input to any system where the transfer function is H(w), the resulting output is

$$G(w) = 1/2\ H(w)\ [\underline{P}(w + w_c) + \underline{P}(w - w_c)] \ .$$

Hence, in the time domain

$$g(t) = 1/2 \int_{-\infty}^{\infty} H(w' - w_c)\, \underline{P}(w')\, e^{j(w' - w_c)t}\, dw'$$

$$+ 1/2 \int_{-\infty}^{\infty} H(w' + w_c)\, \underline{P}(w')\, e^{j(w' + w_c)t}\, dw' \ .$$

If we use the Hermetian properties

$$H(-w) = H^*(w)$$

$$\underline{P}(-w) = P^*(w) \ ,$$

we may write

$$g(t) = R_e \left[e^{-jw_c t} \int_{\infty}^{\infty} H(w' - w_c)\, \underline{P}(w')\, e^{jw't}\, dw' \right] .$$

If we define

$$A(t) + jB(t) = \int_{-\infty}^{\infty} H(w' - w_c)\, \underline{P}(w')\, e^{jw't}\, dw' \ ,$$

then

$$g(t) = A(t) \cos w_c t + B(t) \sin w_c t$$

$$= C(t) \cos (w_c t + \Theta(t))$$

where,

$$C(t) = \sqrt{A^2(t) + B^2(t)} = \left| \int_{-\infty}^{\infty} H(w' - w_c)\, \underline{P}(w')\, e^{jw't}\, dw' \right|$$

and represents the desired pulse response. Based upon this analysis our procedure is:

1. Measure H(w)
2. Transform it to low frequency, that is, obtain $H(w' - w_c)$
3. Multiply by the transform of a pulse, that is, obtain $H(w' - w_c)\ \underline{P}(w')$
4. Take the inverse Fourier Transform and obtain its absolute value.

3. MEASUREMENTS ON A MICROWAVE SYSTEM

Figure 3 is a schematic of a microwave system used to test the pulse measurements and analysis technique. A 90^o hybrid is used to divide the signal into: s_1, a signal that travels through a small, variable and known time delay, T_D and s_2, a signal that is time delayed by a 50 ft cable (time delay ≈ 70 nanosec). Also attenuated by the cable is s_2. The signals are recombined in a magic tee.

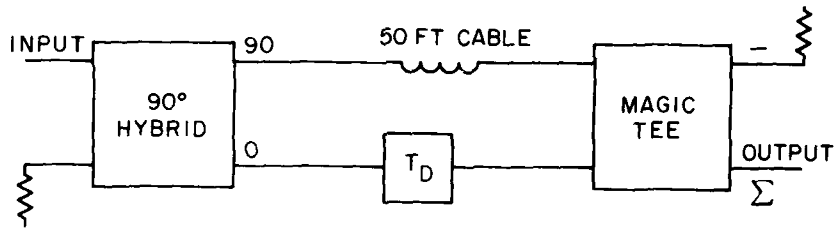


Figure 3. Schematic of Microwave System Used to Test Pulse Measurement System

Figure 4 shows a typical result using a carrier frequency of 3 GHz and using 512 frequency measurements. The onset of s_1 is clearly visible, followed (with a 70 nanosec delay) by a pulse whose height is the vector sum of s_1 and s_2. Finally, the trailing edge of s_2 alone is visible. In this case the time delay T_D is set so that the two signals arrive at the magic tee in phase. Thus, the vector sum equals the scalar sum. The signal shown in Figure 4 varies considerably at times when smooth "flat top" pulses are expected. This is caused by the measurement system. Since the system uses detectors which are not ideal and transmission lines to carry the signals to and from the detectors the measurement includes the system response that we call s(w). Thus, the measured transfer function is

$$S(w)\, H(w)\ .$$

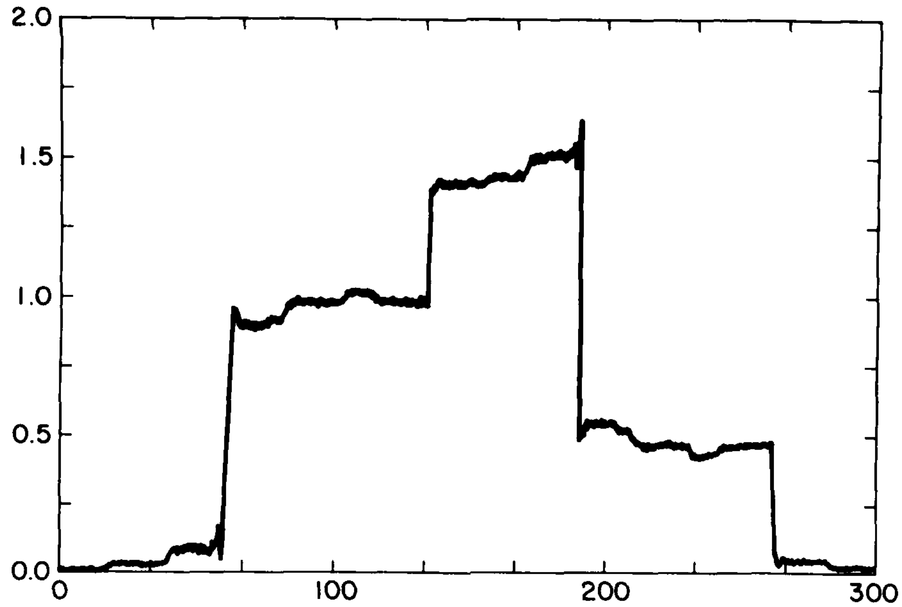


Figure 4. Pulse Response of Microwave System. Pulse width = 125 nanosec, carrier frequency = 3 GHz, $T_D = 0$

The system response S(w) was measured separately, stored in a data file, and used to divide out the system response. The result of using this procedure on the same measurement data that gave the result of Figure 4 is shown in Figure 5. The improvement is clear and the results are now as expected.

Figures 6 and 7 show results for values of T_D which correspond to phase shifts of 60^o and 120^o respectively at the carrier frequency 3 GHz. The effects of the vector combination of the two pulses is clearly evident. Figure 8 shows a comparison of the expected and measured amplitude of the vector sum of the two pulses as a function of the time delay T_D. The agreement is excellent.

4. ANTENNA MEASUREMENTS

Measurements were also made to determine the pulse response of two narrow-band antennas:

1. A horn and narrow-band filter
2. A dipole and corner reflector.

Figure 9 shows the measured amplitude of the transfer function of the horn with narrow-band filter. It has a bandwidth of approximately 10 MHz and a center

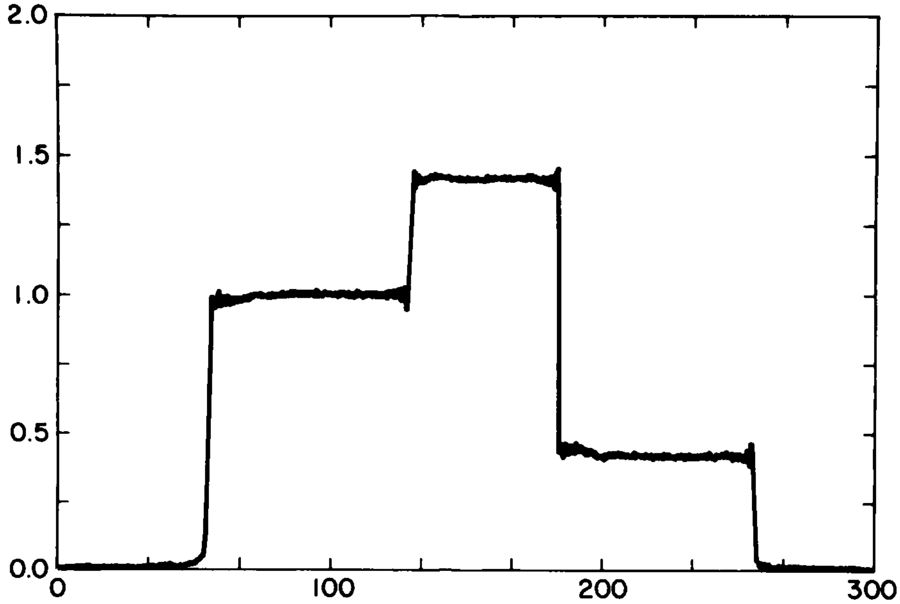


Figure 5. Pulse Response of Microwave System With the Elimination of Measurement System Error. Pulse width = 125 nanosec, carrier frequency = 3 GHz, $T_D = 0$

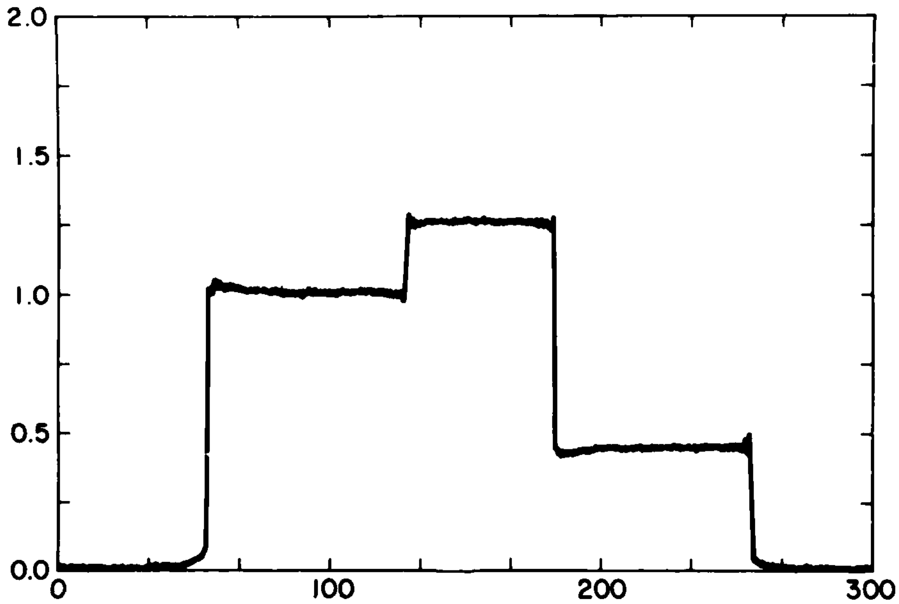


Figure 6. **Pulse** Response of Microwave System. T_D = 1/18 nanosec

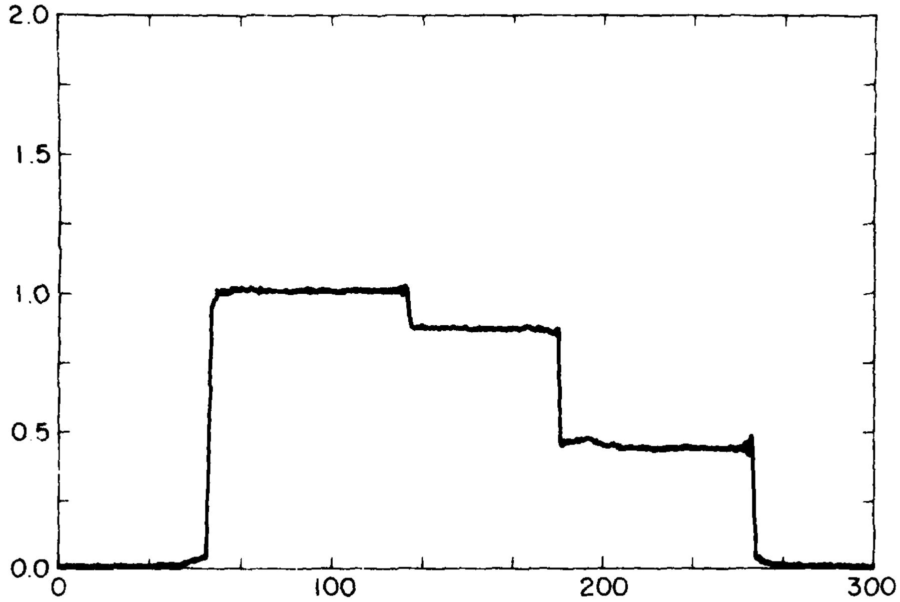


Figure 7. Pulse Response of Microwave System. T_D = 1/9 nanosec

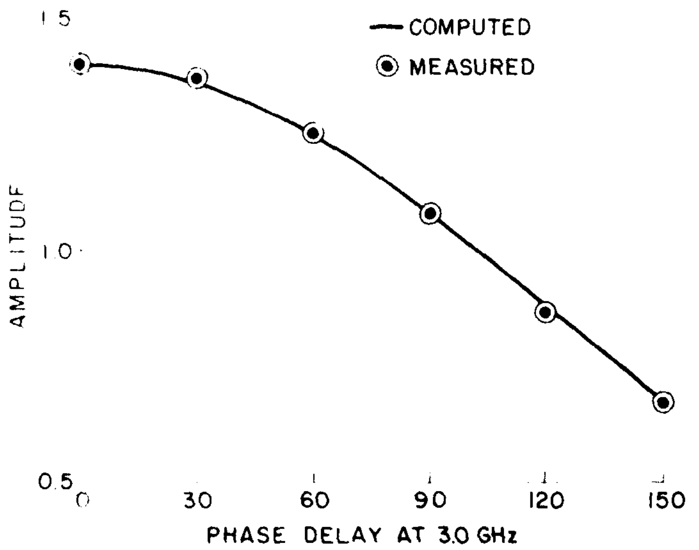


Figure 8. Comparison of Computed and Measured Vector Sum of the Two Pulses Combined by the Magic Tree

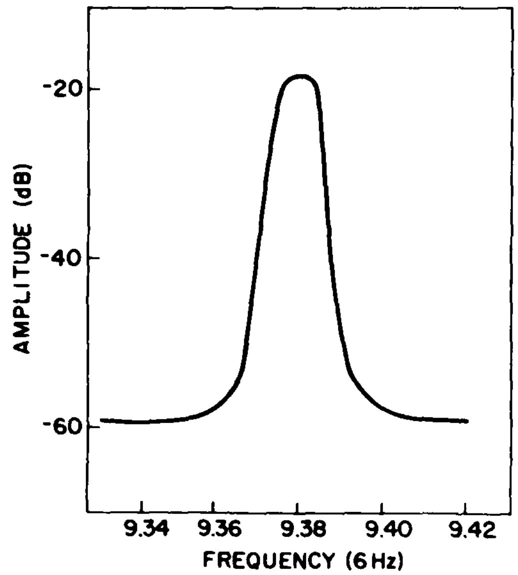


Figure 9. Transfer Function of Horn with Filter

frequency at 9.38 GHz. Figures 10 and 11 show the pulse response of this antenna for a carrier frequency of 9.38 GHz and for pulse widths of 125 and 250 nanosec respectively. The pulse rise time is seen to be approximately 100 nanosec, which is consistent with the bandwidth. Figures 12 through 19 show the pulse response for various values of carrier frequency. The display software is set up so that the pulse normalization and pulse width are variable. In the above cases both were held constant, the latter at 125 nanosec. Figure 20 is a result at a carrier frequency 9.386 GHz for a pulse width of 250 nanosec, but with an output normalization to give a better display of the pulse shape.

The measured transfer function of the dipole with corner reflector is shown in Figure 21. Figures 22 through 27 show the pulse response of this antenna for various carrier frequencies. The response for frequencies near the maximum in the frequency response curve show a rise time of about 10 nanosec and this is consistent with the bandwidth of this antenna.

Measurements were also made on a wideband antenna (a dipole-fed dish antenna) but these results are not presented for the following reasons:

1) At present the software only allows up to 512 data points and frequencies can only be set to a 1 MHz resolution. Both limit the resolution in time.

2) The measured response is actually the response of the transmitting and receiving antennas combined.

3) Difficulties were encountered in the technique for eliminating the measurement system response.

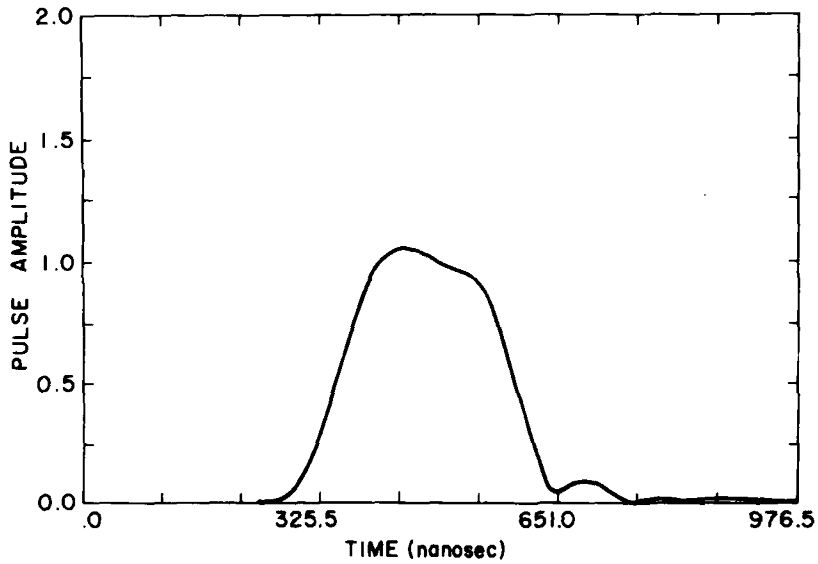


Figure 10. Pulse Response of Horn/Filter. Carrier frequency = 9.38 GHz, pulse width = 125 nanosec

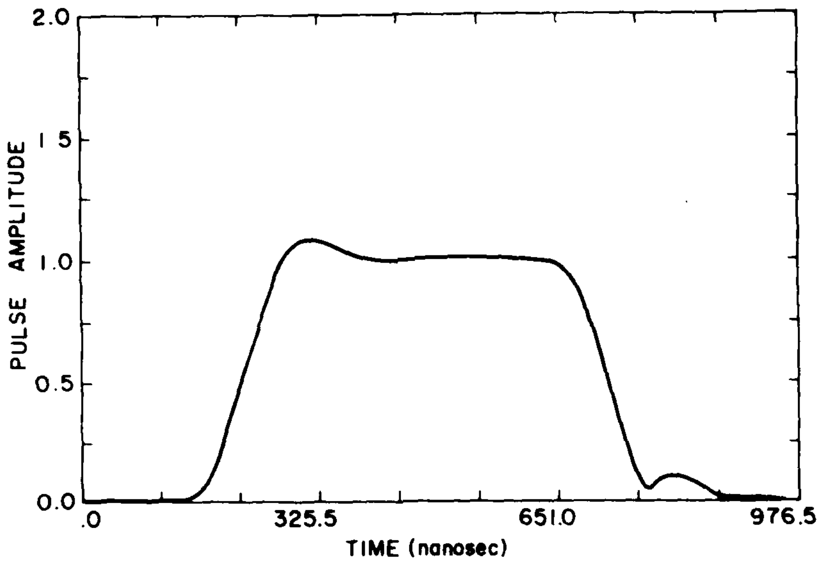


Figure 11. Pulse Response of Horn/Filter. Carrier frequency = 9.38 GHz, pulse width = 250 nanosec

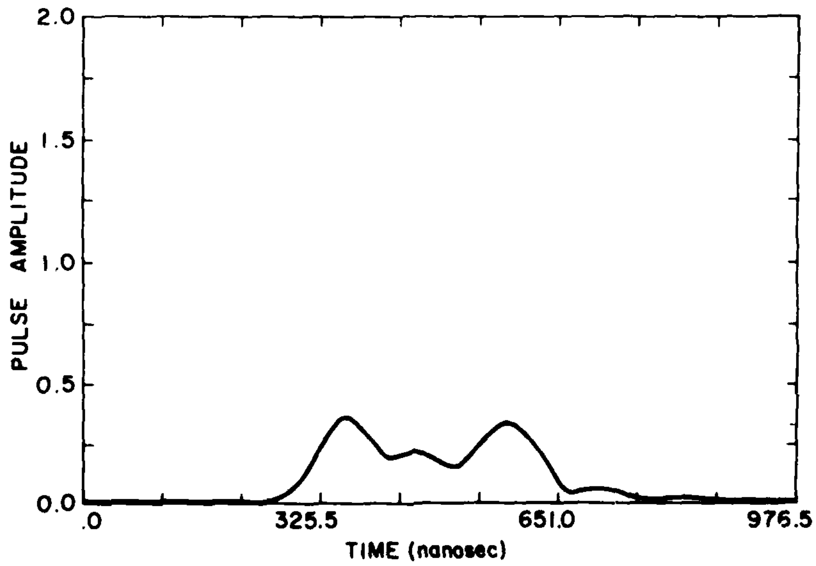


Figure 12. Pulse Response of Horn/Filter. Carrier frequency = 9.372 GHz, pulse width = 125 nanosec

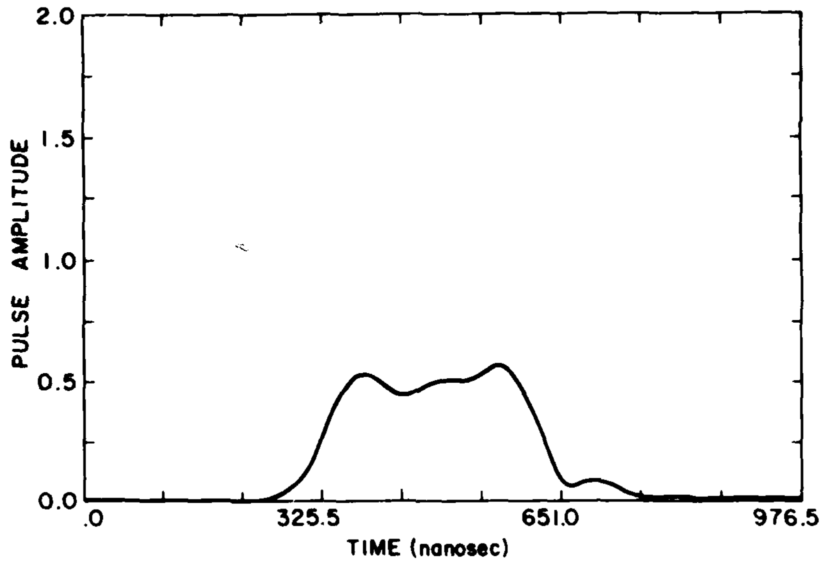


Figure 13. Pulse Response of Horn/Filter. Carrier frequency = 9.374 GHz, pulse width = 125 nanosec

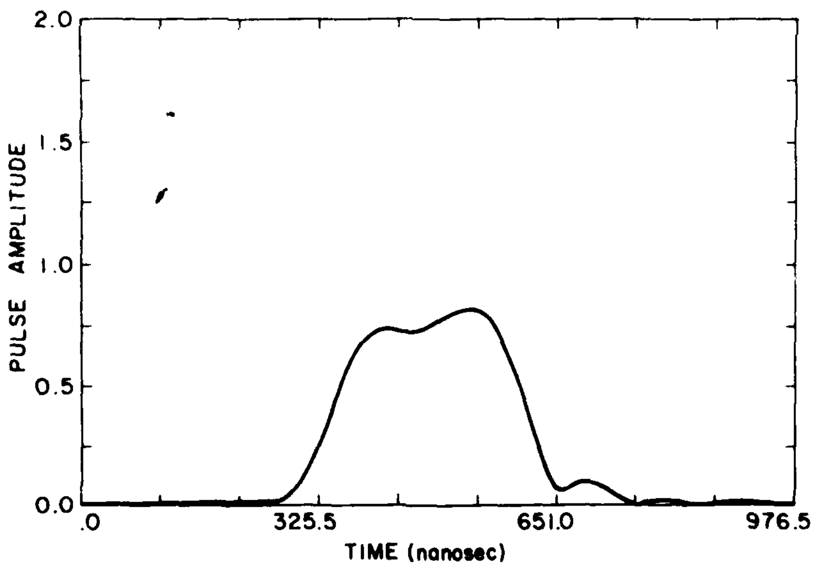


Figure 14. Pulse Response of Horn/Filter. Carrier frequency = 9.376 GHz, pulse width = 125 nanosec

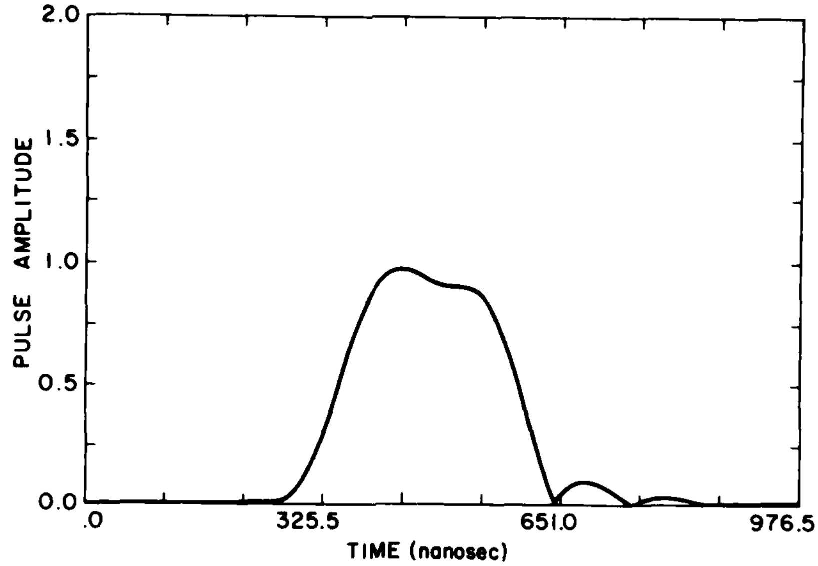


Figure 15. Pulse Response of Horn/Filter. Carrier frequency = 9.378 GHz, pulse width = 125 nanosec

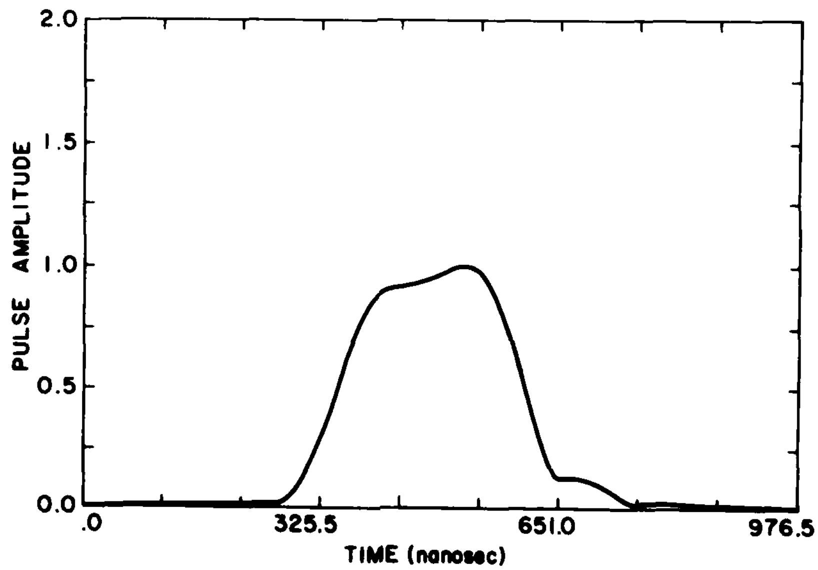


Figure 16. Pulse Response of Horn/Filter. Carrier frequency = 9.382 GHz, pulse width = 125 nanosec

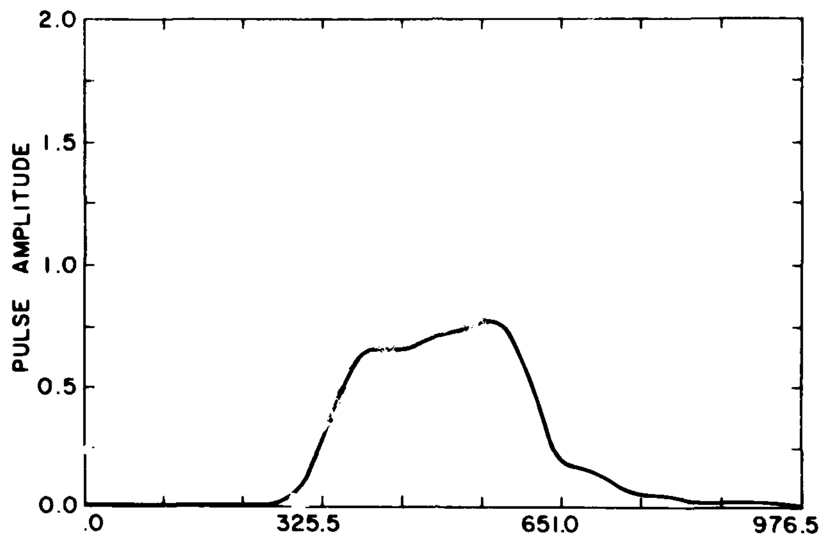


Figure 17. Pulse Response of Horn/Filter. Carrier frequency = 9.384 GHz, pulse width = 125 nanosec

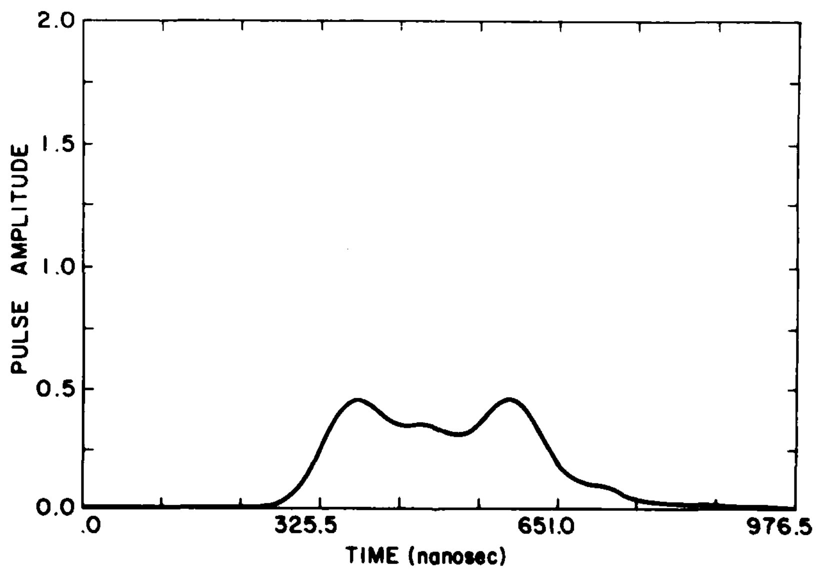


Figure 18. Pulse Response of Horn/Filter. Carrier frequency = 9.386 GHz, pulse width = 125 nanosec

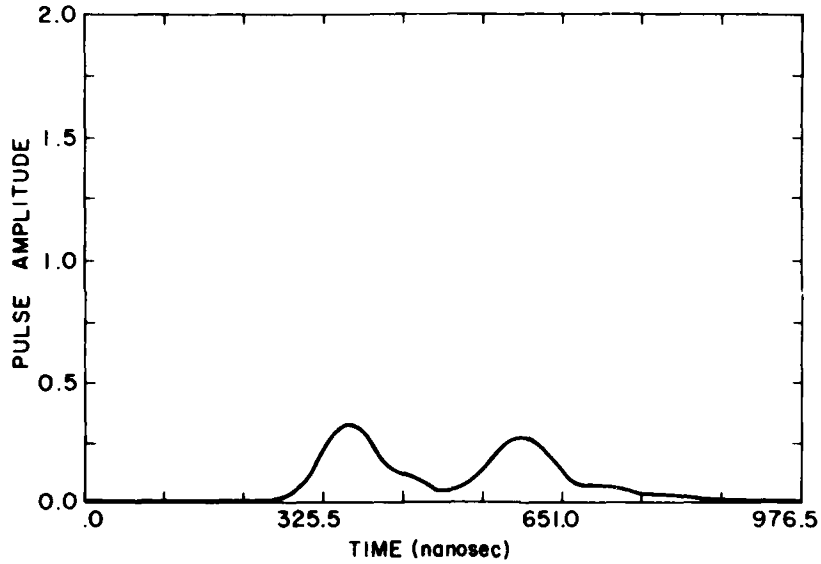


Figure 19. Pulse Response of Horn/Filter. Carrier frequency = 9.388 GHz, pulse width = 125 nanosec

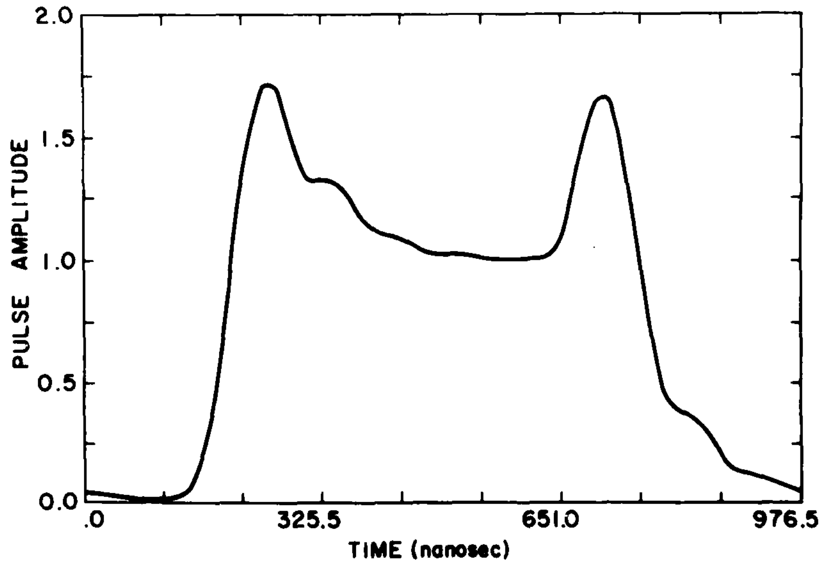


Figure 20. Pulse Response of Horn/Filter Showing Different Pulse Normalization

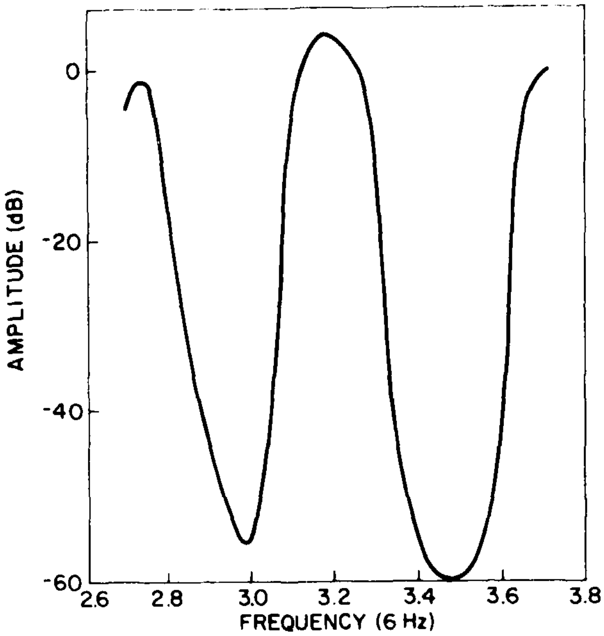


Figure 21. Transfer Function of Dipole with Corner Reflector

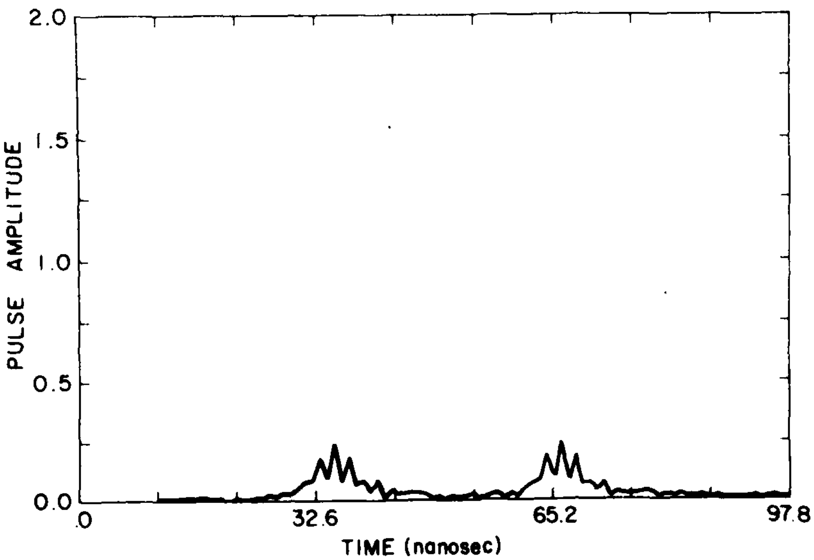


Figure 22. Pulse Response of Dipole With Corner Reflector. Carrier frequency = 3.05 GHz

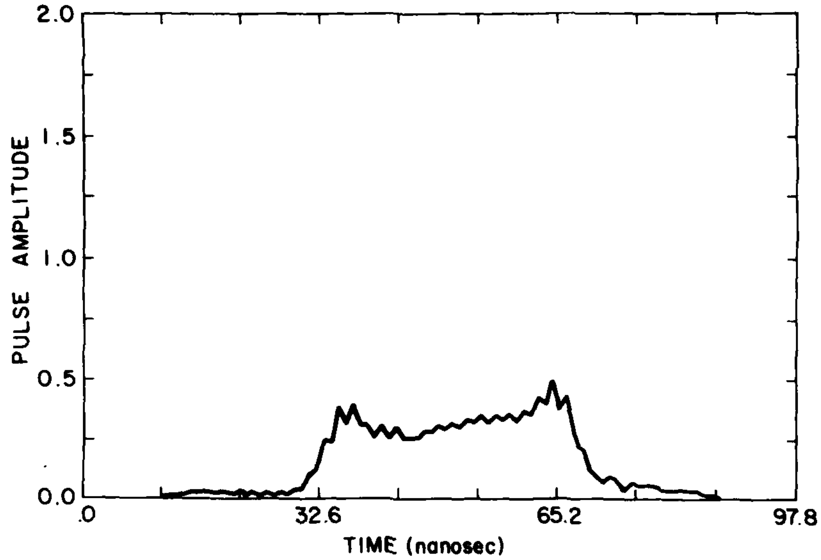


Figure 23. Pulse Response of Dipole With Corner Reflector. Carrier frequency = 3.10 GHz

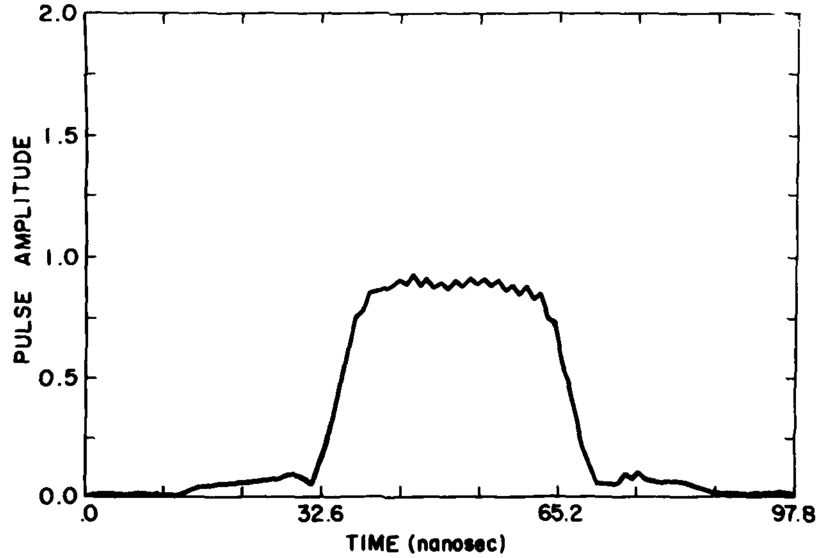


Figure 24. Pulse Response of Dipole With Corner Reflector. Carrier frequency = 3.15 GHz

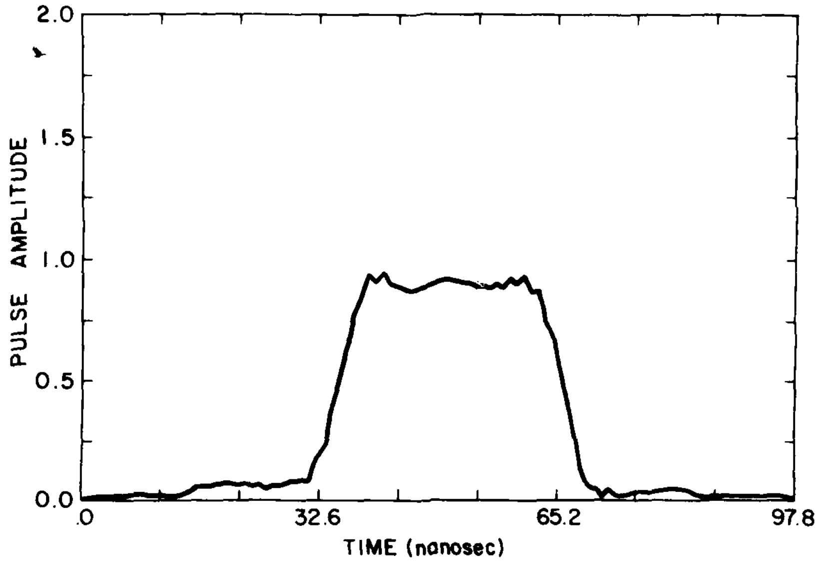


Figure 25. Pulse Response of Dipole With Corner Reflector. Carrier frequency = 3.20 GHz

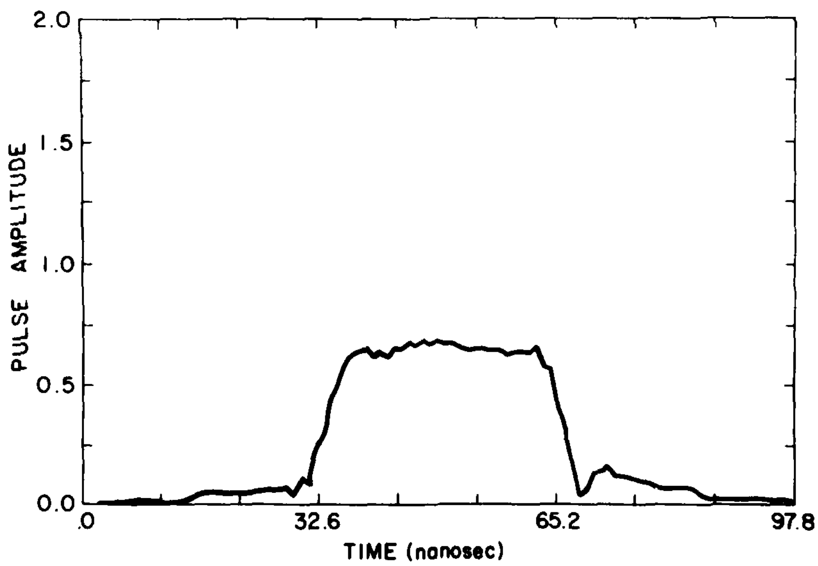


Figure 26. Pulse Response of Dipole With Corner Reflector. Carrier frequency = 3.25 GHz

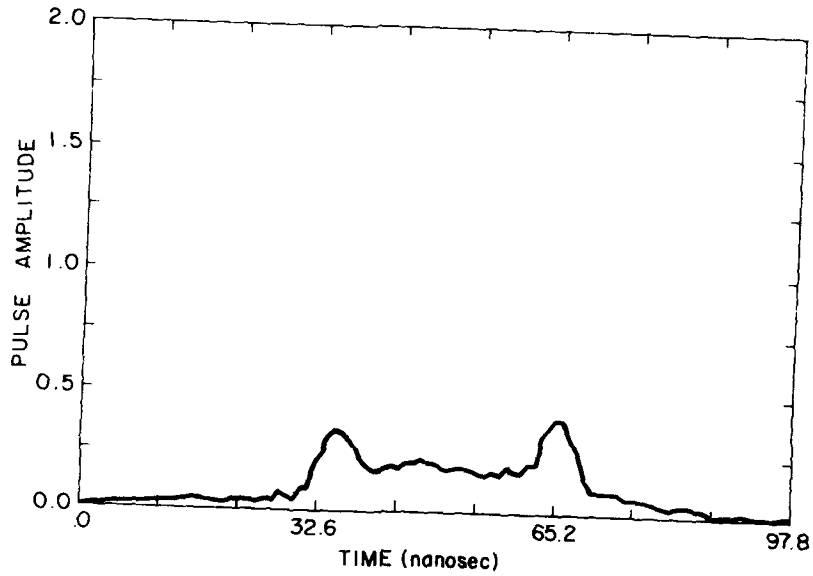


Figure 27. Pulse Response of Dipole With Corner Reflector. Carrier frequency = 3.30 GHz

Appendix A

Description of User Interface

The system software is constructed to operate in accordance with Scientific-Atlanta protocol and is divided into three sections.

1. A test file generator section (File No. PUTG in Appendix B) which obtains parameters from the user (antenna position, carrier frequency, time resolution, etc.) to be used for measurement and analysis. Figure A1 shows a typical test file generation.

2. A Data Acquisition Section (File No. PUAQ in Appendix B) which acquires data and stores it in a data file on disk. This data file contains system parameters and the raw data – that is, amplitude and phase as a function of frequency.

3. A Data Analysis Section which retrieves the information from the data file, does the Fourier analysis, and displays the results. (Files No. PUAN, No. PUAN2, No. PUAN3, No. CFFT, No. CIFT and No. PUFT in Appendix B.) Due to limited memory, the Analysis Section is contained in two segments (second segment overlays the first in memory) with communication taking place via system common. If, in the Test File Generation Section, the user specifies on-line analysis then the Analysis Section is called in automatically. However, if no on-line analysis is specified, control passes back to the RTE Operating System after data acquisition. In this case analysis can still be done by running PUAN directly. Figure A2 shows a direct running of PUAN using Data File DF123 and Figure A3 shows the resulting output. Caution: In order to communicate large blocks of data between the segments of the analysis section it was necessary to write over system common used

```
TFM:WR,PUTG

 *PULSE RESPONSE      TEST FILE NR:
    1.  POSITION
        WANT TO INPUT POSITION VALUES?
YES
        TYPE AZIMUTH POSITION
0
        TYPE ELEVATION POSITION
30
        TYPE AUT PLZN POSITION
45
    2.  FREQUENCY VALUES:
        TYPE CARRIER FREQ
9500
        TYPE REQUIRED RESOLUTION TIME IN NANOSEC
5
        TYPE MIN & MAX FREQUENCIES
9000,10000
        ACTUAL RESOLUTION TIME = 1.95 NANOSEC
        CARRIER FREQ = 9500.00
        FREQ INC = 1.00
        NR FREQ = 512
        START FREQ = 9244.00
        END FREQ = 9755.00
    3.  RECEIVER SETUP
        RECEIVER IF MODE.
             A = A ONLY, B = B ONLY, D = DU.  S = SHARED:
 D
        RECEIVER CRYSTAL CURRENT PRESET?:
 YES


     WIDE (0) OR NARROW (1) SEARCH?
0
    4.  ANALYSIS
        ON LINE ANALYSIS?
YES
        WANT TO OUTPUT FREQ DATA?
NO
        RESULTS TO PRINTER?
YES
        TYPE PULSE WIDTH (EVEN NO. RES. TIMES)
64
        SUBTRACT SYSTEM VALUES?
NO
        TYPE 1, 2 OR 3 TO:
            1.  TO NORMALIZE TO CARRIER FREQ
            2.  TO NORMALIZE TO MAX AMPLITUDE
            3.  FOR UNIT OUTPUT PULSE
2
            TYPE START & END TIMES TO VIEW (NO. RES. TIMES)
1,500
***END OF TEST FILE***

TFM:
```

Figure A1. Typical Test File Generation

```
RU,PUAN
      TYPE DATA FILE NAME
DF123
      TYPE LOGICAL UNIT NO. (1 = TE, 6 = PR):
6
      TYPE 1 TO LIST FREQ DATA, 0 TO NOT LIST
0
      POSITION DATA AVAILABLE IN FILE (1 = YES, 0 = NO)
0
      TYPE 1 TO SUBTRACT SYSTEM VALUES, 0 TO NOT SUBTRACT
0
      TYPE 1, 2 OR 3 TO–
        1. NORMALIZE TO CARRIER FREQ
        2. NORMALIZE TO MAX AMPLITUDE
        3. UNIT OUTPUT PULSE
3
      TYPE POSITION (NO. RES TIMES) TO NORMALIZE TO
256
      TYPE START & END VIEW TIMES (NO. RES TIMES)
1,500
      TYPE PULSE WIDTH (NO. RES TIMES)
64
```

Figure A2. Typical Direct Running of the Analysis Section

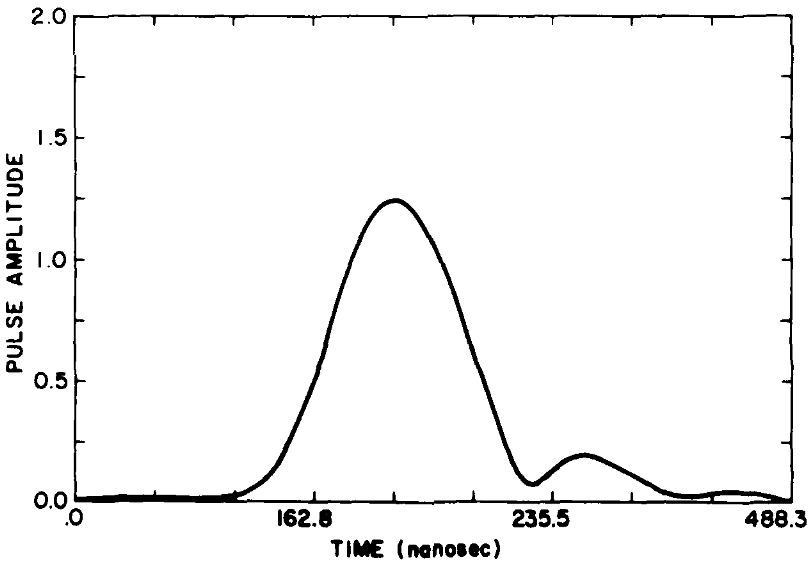


Figure A3. Output Resulting From Running the Analysis Section as Depicted in A2

by Scientific-Atlanta. At times this causes an error on the first call to PUAN; however, a second running of PUAN always gives correct analysis.

The command files shown at the end of Appendix B are used to conveniently integrate the software into the 2020 system. Once the Fourier programs have been compiled and the relocatable code stored in files % PUTG, % PUAQ, etc., the first three command files will load the pulse analysis system. The last two command files are used to back-up the system on magnetic tape.

Appendix B

Software Listings

```
&PUTG  T=00003 IS ON CR00002 USING 00021 BLKS R=0000

FTN4,L
      PROGRAM PUTG(5)
C
C   TEST FILE GENERATOR FOR ANTENNA PULSE RESPONSE
C
      COMMON IVTEK(170)
      COMMON IRTN(3),IFLG(1),LU(1),KFNR(1),IONLN(1),KDFPK(3),
     1KDFUP(3),KOMT(1),IPFAL(1),JPIA(1),IRCVR(1),KRCD(1),ICMPL(1),
     2IDUMA(6),JDISK(1),JBND(6),JBB(6),JBT(6),JITR(6),JTOL(6),
     3JAZ(1),JEL(1),JAUT(1),JSRC(1),JAUX(1),JAUX2(1),JSAZ(6),
     4JXTAL(5),JDUM(27)
C
      COMMON ITGN(3),IACQ(3),IRID(1),IUID(1),I1ID(1),
     1I2ID(1),IAID(1),IEID(1),ITID(1),ISID(1),IUOF(1),IMODE(1),
     2IXTAL(1),IOND(1),ILIST(1),IPLOT(1),KRMAX(1),KUMAX(1),
     3K1MAX(1),K2MAX(1),KAMAX(1),KEMAX(1),NFRQ(1),
     4F(10),NFR(1),IEBM(1),IDBP(1),IDUM(78)
C
C
      DIMENSION NAMSY(3),KNAM(3),LNAM(3)
C
      EQUIVALENCE (NAMSY(1),IDUM(30))
C
      DATA KNAM/2HPU,2HTG,2H  /
      DATA LNAM/2HPU,2HAQ,2H  /
      KKG=0
C
C   ENTRY-IFLAG COMES FROM TFM
C     IFLG=1=LIST
C     IFLG=2=EDIT
C     IFLG=3=WRITE
C
      IF(IFLG .NE. 3)GO TO 90
C   SET TEST AND DATA ACQUISITION FILES INTO SYSTEM COMMON
      DO 95 I=1,3
      ITGN(I)=KNAM(I)
95    IACQ(I)=LNAM(I)
C
90    KGO=0
C   FOR FILE CREATION WRITE HEADING WITHOUT FILE NO.
100   IF(IFLG .EQ. 3)WRITE(1,101)
C   FOR FILE EDIT OR LIST WRITE HEADING WITH FILE NO.
      IF(IFLG .EQ. 1 .OR. IFLG .EQ. 2)WRITE(1,101)KFNR
101   FORMAT(1X,"*PULSE RESPONSE   TEST FILE NR:",I2)
C   CODE FOR POSITION
      KNR=1
99    WRITE(1,102)KNR
102   FORMAT(1X,I3,".POSITION")
C   IF LIST OR IF ENTRY INTO EDIT SIMPLY LIST
      IF(IFLG .EQ. 1 .OR. (IFLG .EQ. 2 .AND. KGO .EQ. 0))GO TO 120
110   WRITE(1,1022)
      CALL NOYES(JJDUM)
1022  FORMAT(5X,"WANT TO INPUT POSITION VALUES?")
      IDUM(15)=JJDUM
      IF(JJDUM .EQ. 0)GO TO 1053
      WRITE(1,105)
105   FORMAT(5X,"TYPE AZIMUTH POSITION")
      READ(1,*)POSA
      KAMAX=POSA*100.0
      WRITE(1,1050)
1050  FORMAT(5X,"TYPE ELEVATION POSITION")
      READ(1,*)POSE
```

```
      KEMAX=POSE*100.0
      WRITE(1,1051)
1051  FORMAT(5X,"TYPE AUT PLZN POSITION")
      READ(1,*)POSP
      KUMAX=POSP*100.0
1053  IF(KGO .NE. 0)GO TO 180
      GO TO 130
120   IF(IDUM(15) .EQ. 0)GO TO 125
      POSA=KAMAX/100.0
      POSE=KEMAX/100.0
      POSP=KUMAX/100.0
      WRITE(1,103)POSA,POSE,POSP
103   FORMAT(5X,"AZIMUTH=",F8.2/5X,"ELEVATION=",F8.2,
     1/5X,"AUT PLZN=",F8.2)
      GO TO 130
125   WRITE(1,126)
126   FORMAT(5X,"NO POSITION DATA")
C   CODE FOR FREQUENCY VALUES
130   KNR=KNR+1
98    WRITE(1,104)KNR
104   FORMAT(1X,I3,".FREQUENCY VALUES:")
      IF(IFLG .EQ. 1 .OR. (IFLG .EQ. 2 .AND. KGO .EQ. 0))GO TO 150
140   WRITE(1,106)
106   FORMAT(5X,"TYPE CARRIER FREQ")
      READ(1,*)FCC
      WRITE(1,1060)
1060  FORMAT(5X,"TYPE REQUIRED RESOLUTION TIME IN NANOSEC")
      READ(1,*)RSEC
1064  WRITE(1,1061)
1061  FORMAT(5X,"TYPE MIN & MAX FREQUENCIES")
      READ(1,*)FMIN,FMAX
      NFRQ=1000./RSEC
      IDFRQ=1
      IRT=NFRQ
1062  IF(IRT .LE. 512)GO TO 1063
      IDFRQ=IDFRQ+1
      IRT=NFRQ/IDFRQ
      GO TO 1062
1063  NFRQ=IRT
      FDEL=FMAX-FCC
      IF(FCC-FMIN .LT. FDEL)FDEL=FCC-FMIN
      IFDEL=FDEL
      ICO=0
      ISIZ=NFRQ
1069  ISIZ=ISIZ/2
      ICO=ICO+1
      IF(ISIZ .NE. 1)GO TO 1069
      NDF2=2**(ICO-1)
      IF(NDF2*IDFRQ .LT. IFDEL)GO TO 1066
      WRITE(1,1065)
1065  FORMAT(1X,"RESOLUTION TIME TOO SMALL FOR ALLOWED FREQ RANGE")
      GO TO 140
1066  NFRQ=2*NDF2
1067  IF(NFRQ*IDFRQ .GT. IFDEL)GO TO 1068
      IF(NFRQ .GT. 256)GO TO 1052
      NFRQ=2*NFRQ
      GO TO 1067
1052  IDFRQ=IDFRQ+1
      GO TO 1067
1068  CONTINUE
      F(1)=FCC-IDFRQ*NFRQ/2
      F(2)=FCC+IDFRQ*(NFRQ/2-1)
      F(3)=IDFRQ
      RSEC=1000./F(3)/NFRQ
```

```
      WRITE(1,119)RSEC
119   FORMAT(5X,"ACTUAL RESOLUTION TIME=",F7.2," NANOSEC")
      F(4)=RSEC
      F(5)=FCC
      F(6)=FMIN
      F(7)=FMAX
      KKG=1
      GO TO 150
1181  IF(KGO .NE. 0)GO TO 180
      GO TO 160
150   NFRQ=(F(2)-F(1))/F(3)+1.5
      WRITE(1,107)F(5),F(3),NFRQ
107   FORMAT(5X,"CARRIER FREQ=",F8.2/5X,"FREQ INC=",F8.2/5X,
     1"NR FREQ=",I5)
      FCC=F(5)
      WRITE(1,1071)F(1),F(2)
1071  FORMAT(5X,"START FREQ=",F7.2/5X,"END FREQ=",F7.2)
      IF(KKG .EQ. 1)GO TO 1181
      KKF=0
C   CODE FOR RECEIVER SETUP
160   KNR=KNR+1
      WRITE(1,162)KNR
162   FORMAT(1X,I3,".RECEIVER SETUP")
      IF(IFLG .EQ. 1 .OR. (IFLG .EQ. 2 .AND. KGO .EQ. 0))GO TO 165
166   WRITE(1,163)
163   FORMAT(5X,"RECEIVER IF MODE."/
     17X,"A=A ONLY,B=B ONLY,D=DUAL,S=SHARED:")
      READ(1,164)IMODE
164   FORMAT(R1)
      IF(IMODE .NE. 101B .AND. IMODE .NE. 102B .AND. IMODE .NE.
     1104B .AND. IMODE .NE. 123B)166,167
167   WRITE(1,168)
168   FORMAT(5X,"RECEIVER CRYSTAL CURRENT PRESET?:")
      CALL NOYES(IXTAL)
      WRITE(1,1680)
1680  FORMAT(5X,"WIDE(0) OR NARROW(1) SEARCH?")
      READ(1,*)JXTAL(4)
      IF(KGO .NE. 0)GO TO 180
      GO TO 190
165   IF(IMODE .EQ. 101B)WRITE(1,1651)
      IF(IMODE .EQ. 102B)WRITE(1,1652)
      IF(IMODE .EQ. 104B)WRITE(1,1653)
      IF(IMODE .EQ. 123B)WRITE(1,1654)
1651  FORMAT(8X,"A-ONLY")
1652  FORMAT(8X,"B-ONLY")
1653  FORMAT(8X,"DUAL MODE")
1654  FORMAT(8X,"SHARED MODE")
      IF(IXTAL .EQ. 1)WRITE(1,1655)
      IF(IXTAL .EQ. 0)WRITE(1,1656)
1655  FORMAT(8X,"CRYSTAL CURRENT IS PRESET")
1656  FORMAT(8X,"CRYSTAL CURRENT NO PRESET")
      IF(JXTAL(4) .EQ. 0)WRITE(1,1657)
      IF(JXTAL(4) .NE. 0)WRITE(1,1658)
1657  FORMAT(8X,"WIDE SEARCH")
1658  FORMAT(8X,"NARROW SEARCH")
C   CODE FOR ANALYSIS SECTION
190   KNR=KNR+1
      WRITE(1,191)KNR
191   FORMAT(1X,I3,".ANALYSIS")
      IF(IFLG .EQ. 1 .OR. (IFLG .EQ. 2 .AND. KGO .EQ. 0))GO TO 195
193   WRITE(1,194)
194   FORMAT(5X,"ON LINE ANALYSIS?")
      CALL NOYES(IOND)
      IANAL=IOND
```

```
      WRITE(1,1741)
1741  FORMAT(5X,"WANT TO OUTPUT FREQ DATA?")
      CALL NOYES(JJDUM)
      IDUM(20)=JJDUM
      WRITE(1,1742)
1742  FORMAT(5X,"RESULTS TO PRINTER?")
      CALL NOYES(JJDUM)
      IDUM(21)=JJDUM
      WRITE(1,1747)
1747  FORMAT(5X,"TYPE PULSE WIDTH(EVEN # RES. TIMES)")
      READ(1,*)IPW
      IDUM(25)=IPW
      WRITE(1,1743)
1743  FORMAT(5X,"SUBTRACT SYSTEM VALUES?")
      CALL NOYES(JJDUM)
      IDUM(23)=JJDUM
      IF(JJDUM .EQ. 0)GO TO 198
      WRITE(1,1745)
1745  FORMAT(5X,"TYPE SYSTEM DATA FILE NAME")
      READ(1,1746)NAMSY
1746  FORMAT(3A2)
198   WRITE(1,1744)
1744  FORMAT(5X,"TYPE 1,2 OR 3 TO:"/6X,"1.TO NORMALIZE TO CARRIER FREQ'
     16X,"2.TO NORMALIZE TO MAX AMPLITUDE"/6X,"3.FOR UNIT OUTPUT PULSE'
      READ(1,*)IDUM(24)
      IF(IDUM(24) .NE. 3)GO TO 1951
      WRITE(1,1952)
1952  FORMAT(8X,"TYPE POSITION(# RES TIMES)TO NORMALIZE TO")
      READ(1,*)IDUM(26)
1951  WRITE(1,1953)
1953  FORMAT(8X,"TYPE START & END TIMES TO VIEW(# RES TIMES)")
      READ(1,*)IDUM(27),IDUM(28)
      GO TO 180
195   IF(IOND .EQ. 0)WRITE(1,196)
      IF(IOND .NE. 0)WRITE(1,197)
196   FORMAT(5X,"NO ON LINE ANALYSIS")
197   FORMAT(5X,"ON LINE ANALYSIS WILL BE DONE")
      IF(IDUM(20) .EQ. 1)WRITE(1,1971)
      IF(IDUM(20) .EQ. 0)WRITE(1,1972)
1971  FORMAT(5X,"FREQ DATA WILL BE OUTPUT")
1972  FORMAT(5X,"FREQ DATA WILL NOT BE OUTPUT")
      IF(IDUM(21) .EQ. 1)WRITE(1,1973)
      IF(IDUM(21) .EQ. 0)WRITE(1,1974)
1973  FORMAT(5X,"OUTPUT TO PRINTER")
1974  FORMAT(5X,"OUTPUT TO TERMINAL")
      PUWD=IDUM(25)*RSEC
      WRITE(1,1072)PUWD
1072  FORMAT(5X,"PULSE WIDTH=",F8.2," NANOSEC")
      IF(IDUM(23) .EQ. 1)WRITE(1,1975)
      IF(IDUM(23) .EQ. 0)WRITE(1,1976)
1975  FORMAT(5X,"SYSTEM VALUES WILL BE SUBTRACTED")
1976  FORMAT(5X,"SYSTEM VALUES WILL NOT BE SUBTRACTED")
      IF(IDUM(24) .EQ. 1)WRITE(1,1977)
      IF(IDUM(24) .EQ. 2)WRITE(1,1978)
      IF(IDUM(24) .EQ. 3)WRITE(1,1979)
1977  FORMAT(5X,"NORMALIZE TO CARRIER")
1978  FORMAT(5X,"NORMALIZE TO MAX AMPLITUDE")
1979  FORMAT(5X,"UNIT OUTPUT PULSE")
      IF(IDUM(24) .NE. 3)GO TO 1001
      TNOR=RSEC*IDUM(26)
      WRITE(1,1002)TNOR
1002  FORMAT(8X,"NORMALIZE TO OUTPUT AT",F8.2," NANOSEC")
1001  STIM=RSEC*IDUM(27)
      ETIM=RSEC*IDUM(28)
```

```
      WRITE(1,1803)STIM,ETIM
1803  FORMAT(8X,"VIEW START TIME=",F8.2,"NANOSEC"/
     18X,"VIEW END TIME=",F8.2," NANOSEC")
      GO TO 180
180   WRITE(1,108)
108   FORMAT(1X,"***END OF TEST FILE***")
      GO TO(250,170,250)IFLG
170   WRITE(1,109)
109   FORMAT(1X,"TYPE LINE NO. TO EDIT (-1 TO END)")
      READ(1,*)ICC
      KGO=1
      ICC=ICC+1
      GO TO(250,110,140,166,193,250)ICC
C    RETURN TO TFM
250   CALL EXEC(8,IRTN)
      CALL MAIN
      END
      ENDS
```

```
C
C     BEGIN FREQ
C
        MDFM(33)=2HBF
        MDFM(35)=32
C
C     END FREQ
C
        MDFM(39)=2HEF
        MDFM(41)=32
C
C     STEP FREQ
C
        MDFM(45)=2HSF
        MDFM(47)=32
C
C     DATA POINT MARKER
C
        MDFM(49)=NFRQ
        MDFM(51)=2HDP
        MDFM(52)=0
C
C     FREQ
C
        MDFM(54)=-2
        MDFM(56)=2HFR
        MDFM(58)=16
C
C     AMPLITUDE
C
        MDFM(60)=-1
        MDFM(62)=2HAA
        MDFM(63)=3
        MDFM(64)=-14
C
C     PHASE
C
        MDFM(68)=-1
        MDFM(70)=2HPA
        MDFM(71)=3
        MDFM(72)=-13
C
C     SET DISK
C
        JDISK=1
C
C     TEMP SET FOR NO BMAX
C
        MDFM(14)=0
C
C     SET TF FILE
C
        ITGN(1)=2HPU
        ITGN(2)=2HTG
        ITGN(3)=2H
        ITGN(4)=2HPU
        ITGN(5)=2HAQ
        ITGN(6)=2H
C
C     OPEN FILE & TRANSFER FORMATS
C
10      CALL DFPK(1,1,1,LERR)
C
C     TRANSFER TF
```

```
0PUAQ  T=00003 IS ON CR00002 USING 00021 BLKS R=0000

FTN4,L
      PROGRAM PUAQ(5)
      COMMON IVTEK(170)
      COMMON IRTN(3),IFLG(1),LU(1),KFNR(1),IONLN(1),KDFPK(3),
     1KDFUP(3),KOMT(1),IPFAL(1),JPIA(1),IRCVR(1),KRCD(1),ICMPL(1),
     2IDUMA(6),JDISK(1),JBND(6),JBB(6),JBT(6),JITR(6),JTOL(6),
     3JAZ(1),JEL(1),JAUT(1),JSRC(1),JAUX(1),JAUX2(1),JSAZ(6),
     4JXTAL(5),JDUM(27)
      COMMON ITGN(3),IACQ(3),IRID(1),IUID(1),I1ID(1),
     1I2ID(1),IAID(1),IEID(1),ITID(1),ISID(1),IUOF(1),IMODE(1),
     2IXTAL(1),IOND(1),ILIST(1),IPLOT(1),KRMAX(1),KUMAX(1),
     3K1MAX(1),K2MAX(1),KAMAX(1),KEMAX(1),NFRQ(1),
     4F(10),NFR(1),IEBM(1),IDBP(1),IDUM(78)
      COMMON IEEE(128),MIAM(8),MDFM(120)
      DIMENSION KDNAM(3),KTFM(3),KANAM(3)
      DIMENSION FF(3),ICC(128),IDAT(8),KKNAM(5),POS(3)
      EQUIVALENCE (IA,IDAT(3)),(IMA,IDAT(4)),(ISA,IDAT(5))
      EQUIVALENCE (IP,IDAT(6)),(IPR,IDAT(7)),(ILS,IDAT(8))
      DATA KKNAM/2HCO,2HMM,2HT ,2HTF,0/
      DATA KDNAM/2HDF,2HM ,2H  /
      DATA KTFM/2HTF,2HM ,2H  /
      DATA KANAM/2HPU,2HAN,2H  /
C
C   INITIALIZE FORMATS
C
      DO 1 I=1,8
1     MIAM(I)=0
      DO 2 I=1,120
2     MDFM(I)=0
      DO 3 I=1,74
3     MDFM(I)=1
C
C   TEST FILE
C
      MDFM(2)=-128
      MDFM(4)=2HTF
      MDFM(6)=40000B-15
C
C   COMMENTS
C
      MDFM(8)=-128
      MDFM(10)=2HCO
      MDFM(12)=16
      IF(KOMT .EQ. 0)MDFM(8)=0
C
C   BEAM MAX
C
      MDFM(14)=-128
      MDFM(16)=2HBM
      MDFM(18)=40000B-15
C
C   POSITION MARKER
C
      MDFM(22)=2HPM
      MDFM(23)=0
C
C   POSITION
C
      MDFM(25)=-3
      MDFM(27)=2HPO
      MDFM(29)=32
      IF(IDUM(15) .EQ. 0)MDFM(25)=0
```

```
C
      CALL DFPK(2,ITGN,128,LERR)
C
C   TRANSFER COMMENTS
C
      IF(KOMT .EQ. 0)GO TO 45
      CALL DFPK(3,KKNAM,128,LERR)
 45   IF(IDUM(15) .EQ. 0)GO TO 46
C
C   TRANSFER POSITION
C
      POS(1)=KAMAX/100.0
      POS(2)=KEMAX/100.0
      POS(3)=KUMAX/100.0
      DO 452 I=1,3
      ANG=POS(I)
      IAX=I
      CALL PSN(IAX,ANG,ISTAT)
      IF(ISTAT .NE. 0)WRITE(1,451)
      CALL SYN0(ANGM,IAST)
      CALL SYN1
      IF(IAST .NE. 0)WRITE(1,451)
      POS(I)=ANGM
 452  CONTINUE
 451  FORMAT(1X,"POSITION ERROR")
      CALL DFPK(2,POS,6,LERR)
C
C   TRANSFER BEG,END,STEP FREQ
C
 46   DO 47 I=1,3
 47   FF(I)=F(I)
      CALL DFPK(2,FF,6,LERR)
C   SET VARIABLES FOR LOWEST ATTENUATION
      IFA=0
      IFB=0
C
C   SET UP & TRANSFER FREQ,AMP,PHASE DATA
C
C   SET UP RECEIVER
C   CHOOSE REMOTE TUNING
      ILR=1
C   ENABLE APC SEARCH
      IAPC=1
C   USE WIDE OR NARROW SEARCH DEPENDING ON JXTA(4)
C   DISABLE REFERENCE CHECK
      IREF=0
C   CHOOSE MODE
      IFF=-1
      IF(IMODE .EQ. 101B)IFF=1
      IF(IMODE .EQ. 102B)IFF=2
      IF(IMODE .EQ. 104B)IFF=3
      IF(IMODE .EQ. 123B)IFF=0
      CALL RMODE(ILR,IAPC,JXTAL(4),IXTAL,IREF,IFF)
C   SET RECEIVER TO AUTO
      CALL RMAN(1)
      FZ=FF(1)
      CALL FREQ(0,FZ,FCNTR,ISTAT)
C   SET DATA TO 1
      DO 11 I=1,8
 11   IDAT(I)=1
C   INITIALIZE RATIOMETER
      CALL RAT0(IA,IMA,ISA,IB,IMB,ISB,ISTA)
C   INITIALIZE PHASE DISPLAY
      CALL PHA0(IP,IPR,ILS,ISTP)
```

```
C    DO MEASUREMENTS FOR EACH FREQUENCY
        PCTOL=F(4)
        DO 12 I=1,NFRQ
        FZ=FF(1)+(I-1)*FF(3)
C    SET FREQUENCY AND MEASURE IT
        ITRY=0
50      CALL FREQ(0,FZ,FCNTR,ISTAT)
        IFZ=FZ
        IFCN=FCNTR+.5
        IF(IFZ .EQ. IFCN)GO TO 53
        ITRY=ITRY+1
        IF(ITRY .LT. 100)GO TO 50
53      CONTINUE
C    RECORD MEASURED VALUE
        IDAT(1)=FCNTR
        IDAT(2)=32767*(FCNTR-IDAT(1))
C    SET ATTENUATION
        CALL RATN(IFA,IFB)
        CALL DLAY(100)
C    CHECK RECEIVER STATUS
        CALL RSTAT(ILOK,IORNG)
        IJU=ILOK+1
        GO TO(100,200)IJU
100     WRITE(1,15)
15      FORMAT(1X,"NO PHASE LOCK")
200     CONTINUE
C    TRIGGER RATIOMETER
290     CALL RAT1
C    GET DATA
        ITRY=0
C    CHECK STATUS OF RATIOMETER
300     CALL RAT2
        IF(ISTA .EQ. 0)GO TO 550
        IF(ITRY .EQ. 101)GO TO 540
        CALL DLAY(10)
        ITRY=ITRY+1
        GO TO 300
540     WRITE(1,5000)
5000    FORMAT(1X,"RATIO TIMEOUT")
        GO TO 1000
C    DB VALUES MUST BE NEGATIVE
550     IF(IB .GE. 0)IFB=IFB+1
        IF(IA .GE. 0)IFA=IFA+1
        IF(IA .LT. 0 .AND. IB .LT. 0)GO TO 580
        IF(IFA .EQ. 7 .OR. IFB .EQ. 7)GO TO 590
        CALL RATN(IFA,IFB)
        CALL DLAY(100)
        GO TO 290
590     WRITE(1,5500)
5500    FORMAT(1X,"AMPLITUDE TOO HIGH")
        GO TO 1000
580     CONTINUE
        IATE=IA
        IBTE=IB
        IA=IA+50*IFA
        IB=IB+50*IFB
        IF(IATE .LT. -300)IFA=0
        IF(IBTE .LT. -300)IFB=0
C    TRIGGER PHASE DISPLAY
        CALL PHA1
C    GET DATA
        ITRY=0
C    CHECK STATUS OF PHASE METER
450     CALL PHA2
```

```
      IF(ISTP .EQ. 0)GO TO 480
      IF(ITRY .GE. 101)GO TO 470
      CALL DLAY(10)
      ITRY=ITRY+1
      GO TO 450
470   WRITE(1,4500)
4500  FORMAT(1X,"PHASE TIMEOUT")
      GO TO 1000
480   CONTINUE
C   TRANSFER DATA
      CALL DFPK(2,IDAT,8,LERR)
12    CONTINUE
C   CLOSE DATA FILE
      CALL DFPK(8,1,1,LERR)
      ICMPL=1
      IF(IONO .NE. 0)400,500
1000  WRITE(1,1001)
1001  FORMAT(1X,"DATA FILE ABORTED")
      CALL DFPK(7,IDUMY,IDUMY,LERR)
      WRITE(1,1002)
1002  FORMAT(1X,"TRY AGAIN?")
      CALL NOYES(ITRY)
      IF(ITRY .NE. 0)GO TO 10
500   CALL EXEC(8,KTFM)
      CALL MAIN
400   KDFUP(1)=KDFPK(1)
      KDFUP(2)=KDFPK(2)
      KDFUP(3)=KDFPK(3)
      M=0
1005  ICODE=100000B+9
      CALL EXEC(ICODE,KANAM)
      M=1
      IF(M .EQ. 1)GO TO 405
      GO TO 500
405   WRITE(1,401)
401   FORMAT(1X,"ERROR IN SCHEDULING ANALYSIS PROGRAM",
     1/2X,"TRY AGAIN?")
      CALL NOYES(ITRY)
      IF(ITRY .NE. 0)GO TO 1005
      GO TO 500
      END
      END$
```

&PUAN T=ØØØØ3 IS ON CRØØØØ2 USING ØØØ21 BLKS R=ØØØØ

```
FTN4,L
      PROGRAM PUAN(3)
      COMMON IVTEK(17Ø)
      COMMON IRTN(3),IFLG(1),LU(1),KFNR(1),IONLN(1),KOFPK(3),
     1KDFUP(3),KOMT(1),IPFAL(1),JPIA(1),IRCVR(1),KRCD(1),ICMPL(1),
     2IDUMA(6),JDISK(1),JBND(6),JBB(6),JBT(6),JITR(6),JTOL(6),
     3JAZ(1),JEL(1),JAUT(1),JSRC(1),JAUX(1),JAUX2(1),JSAZ(6),
     4JXTAL(5),JDUM(27)
      COMMON ITGN(3),IACQ(3),IRID(1),IUID(1),I1ID(1),
     1I2ID(1),IAID(1),IEID(1),ITID(1),ISID(1),IUOF(1),IMODE(1),
     2IXTAL(1),IOND(1),ILIST(1),IPLOT(1),KRMAX(1),KUMAX(1),
     3K1MAX(1),K2MAX(1),KAMAX(1),KEMAX(1),NFRQ(1),
     4F(1Ø),NFR(1),IEBM(1),IDBP(1),IDUM(78)
      COMMON IEEE(128),MIAM(8),MDFM(12Ø)
      DIMENSION DB(512),DEG(512)
      DIMENSION ICC(128),FFA(3),IDAT(8),POS(3)
      DIMENSION KANAM(3)
      COMPLEX X(512)
      EQUIVALENCE (ICC(1),MIAM(1))
      DATA KANAM/2HPU,2HAN,2H1 /
      PI=3.1415926
      JSKIP=Ø
      IF(IOND .NE. Ø)4,3
C   OBTAIN DATA FILE NAME
3     WRITE(1,6Ø)
6Ø    FORMAT(1X,"TYPE DATA FILE NAME")
      READ(1,7Ø)KDFUP
7Ø    FORMAT(3A2)
C   OUTPUT TO TERMINAL OR PRINTER?
      WRITE(1,5)
5     FORMAT(1X,"TYPE LOGICAL UNIT NO.(1=TE,6=PR):")
      READ(1,*)LUA
      IDUM(22)=LUA
      WRITE(1,71)
71    FORMAT(1X,"TYPE 1 TO LIST FREQ DATA,Ø TO NOT LIST")
      READ(1,*)JD2Ø
      WRITE(1,72)
72    FORMAT(1X,"POSITION DATA AVAILABLE IN FILE(1=YES,Ø=NO)")
      READ(1,*)JD15
      WRITE(1,73)
73    FORMAT(1X,"TYPE 1 TO SUBTRACT SYSTEM VALUES,Ø TO NOT SUBTRACT")
      READ(1,*)JD23
      IF(JD23 .EQ. Ø)GO TO 75
      WRITE(1,76)
76    FORMAT(1X,"TYPE SYSTEM DATA FILE NAME")
      READ(1,77)IDUM(3Ø),IDUM(31),IDOM(32)
77    FORMAT(3A2)
75    WRITE(1,74)
74    FORMAT(1X,"TYPE 1,2 OR 3 TO-"/3X,"1.NORMALIZE TO CARRIER FREQ"/
     13X,"2.NORMALIZE TO MAX AMPLITUDE"/3X,"3.UNIT OUTPUT PULSE")
      READ(1,*)JD24
      IDUM(24)=JD24
      IF(JD24 .NE. 3)GO TO 78
      WRITE(1,79)
79    FORMAT(1X,"TYPE POSITION(# RES TIMES)TO NORMALIZE TO")
      READ(1,*)IDUM(26)
78    WRITE(1,791)
791   FORMAT(1X,"TYPE START & END VIEW TIMES(# RES TIMES)")
      READ(1,*)IDUM(27),IDUM(28)
      WRITE(1,792)
792   FORMAT(1X,"TYPE PULSE WIDTH(# RES TIMES)")
      READ(1,*)IDUM(25)
```

```
      GO TO 6
4     IOND=0
      JD15=IDUM(15)
      JD20=IDUM(20)
      JD23=IDUM(23)
      JD24=IDUM(24)
      LUA=1
      IF(IDUM(21) .EQ. 1)LUA=6
      IDUM(22)=LUA
6     CONTINUE
C   OPEN FILE & GET FORMATS
      CALL DFUP(1,LERR)
      KERR=1
      IF(LERR .NE. 0)GO TO 101
C   READ & OUTPUT TEST FILE
      CALL DFUP(4,LERR,ICC,128)
      WRITE(LUA,10)ICC
10    FORMAT(1X,32A2)
      KERR=2
      IF(LERR .NE. 0)GO TO 101
C   READ & OUTPUT COMMENTS
      IF(KOMT .EQ. 0)GO TO 35
      CALL DFUP(4,LERR,ICC,128)
      WRITE(LUA,10)ICC
      KERR=3
      IF(LERR .NE. 0)GO TO 101
35    IF(JD15 .EQ. 0)GO TO 25
C   READ & OUTPUT POSITION
      CALL DFUP(4,LERR,POS,6)
      WRITE(LUA,20)POS
20    FORMAT(10X,F8.2)
      KERR=4
      IF(LERR .NE. 0)GO TO 101
C   READ START,END & FREQ INC & OUTPUT
25    CALL DFUP(4,LERR,FFA,6)
      WRITE(LUA,20)FFA
      KERR=5
      IF(LERR .NE. 0)GO TO 101
      NFRQ=(FFA(2)-FFA(1))/FFA(3)+1.5
      N=NFRQ
      NCO=0
100   M=N
      N=N/2
      NCO=NCO+1
      IF(N*2 .NE. M)GO TO 105
      IF(N .NE. 1)GO TO 100
      IF(JSKIP .EQ. 1)GO TO 202
C   FOR EACH FREQ READ & OUTPUT:
C     (1)FREQ > IDAT(1),IDAT(2)
C     (2)AMP  > IDAT(3-5)
C     (3)PHASE> IDAT(6-8)
      IF(JD20 .EQ. 1)WRITE(LUA,45)
45    FORMAT(10X,"FREQ",14X,"AMP(DB)",10X,"DEG")
202   DBMAX=-100
      DO 12 I=1,NFRQ
      CALL DFUP(4,LERR,IDAT,8)
      AMULT=1.0
      IF(IDAT(4) .EQ. 1)AMULT=.1
      IF(IDAT(4) .EQ. 0)AMULT=.01
      IF(AMULT .EQ. 1.0)GO TO 101
      DBSYS=IDAT(3)*AMULT
      DGSYS=0.1*IDAT(6)
      IF(JSKIP .EQ. 1)GO TO 61
      DB(I)=DBSYS
```

```
      DEG(I)=DGSYS
      GO TO 62
61    DB(I)=DB(I)-DBSYS
      DEG(I)=DEG(I)-DGSYS
62    IF(DB(I) .GT. DBMAX)DBMAX=DB(I)
      FCC=IDAT(1)+IDAT(2)/32767.0
      IF(JD20 .EQ. 1)WRITE(LUA,40)FCC,DB(I),DEG(I)
40    FORMAT(3(10X,F8.2))
12    CONTINUE
      KERR=6
      IF(LERR .NE. 0)GO TO 101
      CALL DFUP(6,LERR)
      IF(JD23 .NE. 1)GO TO 230
      IF(JSKIP .EQ. 1)GO TO 230
      DO 201 I=1,3
201   KDFUP(I)=IDUM(29+I)
      JSKIP=1
      GO TO 6
230   CONTINUE
      NFRQ2=NFRQ/2
      IF(JD24 .EQ. 1)DBMAX=DB(NFRQ2+1)
      DO 14 I=1,NFRQ
      DB(I)=DB(I)-DBMAX
14    CONTINUE
      DEG1=DEG(NFRQ2+1)
      DO 15 I=1,NFRQ
      DEG(I)=DEG(I)-DEG1
21    IF(DEG(I) .LE. -180.)DEG(I)=DEG(I)+360.
      IF(DEG(I) .GT. 180.)DEG(I)=DEG(I)-360.
      IF(DEG(I) .LE. -180. .OR. DEG(I) .GT. 180.)GO TO 21
15    CONTINUE
      IWP=IDUM(25)
      CALL PUFT(X,NCO,IWP)
      DO 19 I=1,NFRQ
      RAD=DEG(I)*PI/180.
      AMP=10.0**(DB(I)/20.0)
      IF(I.LE.NFRQ2)X(I+NFRQ2)=AMP*CMPLX(COS(RAD),-SIN(RAD))*X(I+NFRQ2)
      IF(I.GT.NFRQ2)X(I-NFRQ2)=AMP*CMPLX(COS(RAD),-SIN(RAD))*X(I-NFRQ2)
19    CONTINUE
      GO TO 107
105   WRITE(1,102)
102   FORMAT(1X,"NO. OF FREQ NOT A POWER OF TWO")
      GO TO 99
101   WRITE(1,30)KERR,LERR
30    FORMAT(1X,"ERROR IN DFUP # ",I2,"  LERR=",I5)
99    CALL DFUP(6,LERR)
100   CALL EXEC(6)
107   IDUM(1)=ICO
      IDUM(2)=NCO
      IDUM(3)=LUA
      F(3)=FFA(3)
      CALL PUAN2(X)
      GO TO 100
      END
      END$
```

```
@PUAN2 T=ØØØØ3 IS ON CRØØØØ2 USING ØØØØ8 BLKS R=ØØØØ

FTN4,L
      SUBROUTINE PUAN2(X)
      COMMON IVTEK(17Ø)
      COMMON IRTN(3),IFLG(1),LU(1),KFNR(1),IONLN(1),KDFPK(3),
     1KDFUP(3),KOMT(1),IPFAL(1),JPIA(1),IRCVR(1),KRCD(1),ICMPL(1),
     2IDUMA(6),JDISK(1),JBND(6),JBB(6),JBT(6),JITR(6),JTOL'6),
     3JAZ(1),JEL(1),JAUT(1),JSRC(1),JAUX(1),JAUX2(1),JSAZ(6),
     4JXTAL(5),JDUM(27)
C
      COMMON ITGN(3),IACQ(3),IRID(1),IUID(1),I1ID(1),
     1I2ID(1),IAID(1),IEID(1),ITID(1),ISID(1),IUOF(1),IMODE(1),
     2IXTAL(1),IOND(1),ILIST(1),IPLOT(1),KRMAX(1),KUMAX(1),
     3K1MAX(1),K2MAX(1),KAMAX(1),KEMAX(1),NFRQ(1),
     4F(1Ø),NFR(1),IEBM(1),IDBP(1),IDUM(78)
      COMMON IEEE(128),MIAM(8),MDFM(12Ø)
      DIMENSION IDAT(512),KANAM(3)
      COMPLEX X(512)
      EQUIVALENCE (RSEC,JDUM(25))
      EQUIVALENCE (ITGN(1),IDAT(1))
      DATA KANAM/2HPU,2HAN,2H3 /
      RSEC=1ØØØ./(NFRQ-1)/F(3)
      JDUM(27)=IDUM(28)-IDUM(27)
      ICO=IDUM(1)
      NCO=IDUM(2)
      LUA=IDUM(22)
      JD24=IDUM(24)
      NFRQ2=NFRQ/2
      CALL CIFT(X,NCO)
      XR=REAL(X(NFRQ2))
      XI=AIMAG(X(NFRQ2))
      XNOR=SQRT(XR*XR+XI*XI)
      IF(JD24 .NE. 3)XNOR=1.
      IS=IDUM(27)
      IE=IDUM(28)
      DO 1 I=IS,IE
      XR=REAL(X(I))
      XI=AIMAG(X(I))
      XR=SQRT(XR*XR+XI*XI)/XNOR
      IDAT(I-IS+1)=3ØØ.*XR
1     CONTINUE
      ICODE=1ØØØØØB+9
      CALL EXEC(ICODE,KANAM)
      RETURN
      END
      END$
```

```
#PUAN3 T=00003 IS ON CR00002 USING 00008 BLKS R=0000

FTN4,L
      PROGRAM PUAN3(3)
      COMMON IVTEK(170)
      COMMON IRTN(3),IFLG(1),LU(1),KFNR(1),IONLN(1),KDFPK(3),
     1KDFUP(3),KOMT(1),IPFAL(1),JPIA(1),IRCVR(1),KRCD(1),ICMPL(1),
     2IDUMA(6),JDISK(1),JBND(6),JBB(6),JBT(6),JITR(6),JTOL(6),
     3JAZ(1),JEL(1),JAUT(1),JSRC(1),JAUX(1),JAUX2(1),JSAZ(6),
     4JXTAL(5),JDUM(27)
C
      COMMON ITGN(3),IACQ(3),IRID(1),IUID(1),I1ID(1),
     1I2ID(1),IAID(1),IEID(1),ITID(1),ISID(1),IUOF(1),IMODE(1),
     2IXTAL(1),IOND(1),ILIST(1),IPLOT(1),KRMAX(1),KUMAX(1),
     3K1MAX(1),K2MAX(1),KAMAX(1),KEMAX(1),NFRQ(1),
     4F(10),NFR(1),IEBM(1),IDBP(1),IDUM(78)
      COMMON IEEE(128),MIAM(8),MDFM(120)
      DIMENSION IYL(10),IXA(7),IYA(15),IL(2),IDAT(512)
      EQUIVALENCE (ITGN(1),IDAT(1))
      EQUIVALENCE (RSEC,JDUM(25))
      DATA IYA/2H P,2H U,2H L,2H S,2H E,2H  ,2H A,2H M,2H P,2H L,
     12H I,2H T,2H U,2H D,2H E/
      DATA IXA/2HTI,2HME,2H(N,2HAN,2HOS,2HEC,2H) /
      DATA IYL/2H0.,2H0 ,2H0.,2H5 ,2H1.,2H0 ,2H1.,2H5 ,2H2.,2H0 /
      ID=JDUM(27)
      IX0=100
      IY0=100
      CALL QPLOT(5)
      ZZ=0
      DZ=ID*RSEC/3.
      IY1=80
      IX1=50
      DO 5 I=1,4
      CALL QPLOT(0,IX1,IY1)
      WRITE(1,100)ZZ
      IX1=IX1+300
    5 ZZ=ZZ+DZ
  100 FORMAT(F6.1)
      IX1=IX0
      IY1=IY0
      DO 2 I=1,10
      CALL QPLOT(1,IX1,IY1)
      IY2=IY1+600
      CALL QPLOT(3,IX1,IY2)
    2 IX1=IX1+100
      IX1=IX0
      DO 3 J=1,9
      CALL QPLOT(1,IX1,IY1)
      IX2=IX1+900
      CALL QPLOT(3,IX2,IY1)
    3 IY1=IY1+75
      CALL QPLOT(6)
      IX1=0
      IY1=500
      DO 20 I=1,15
      IYAT=IYA(I)
      CALL QPLOT(2,IX1,IY1,IYAT,2)
   20 IY1=IY1-20
      IX1=400
      IY1=40
      CALL QPLOT(2,IX1,IY1,IXA,14)
      IX1=50
      IY1=IY0
      DO 6 I=1,5
```

```
      DO 7 J=1,2
      IZ=2*(I-1)+J
7     IL(J)=IYL(IZ)
      CALL QPLOT(2,IX1,IY1,IL,4)
6     IY1=IY1+15Ø
      CALL QPLOT(1,IXØ,IYØ)
      DO 1 I=1,ID
      IY=IYØ+IDAT(I)
      IX=I*9ØØ./ID+1ØØ
      CALL QPLOT(3,IX,IY)
1     CONTINUE
      END
      END$
```

*CFFT T=ØØØØ3 IS ON CRØØØØ2 USING ØØØØ4 BLKS R=ØØØØ

```
FTN4,L
      SUBROUTINE CFFT(X,M)
C   WILL OBTAIN COMPLEX FFT OF ARRAY Y.
C   M IS POWER OF TWO WHICH GIVES ORDER OF ARRAY
C
      COMPLEX X(1),U,W,T
      N=2**M
      N2=N/2
      N1=N-1
      J=1
      DO 3 I=1,N1
      IF(I .GE. J)GO TO 1
      T=X(J)
      X(J)=X(I)
      X(I)=T
1     K=N2
2     IF(K .GE. J)GO TO 3
      J=J-K
      K=K/2
      GO TO 2
3     J=J+K
      PI=3.1415926
      DO 5 L=1,M
      LE=2**L
      LE1=LE/2
      U=(1.Ø,Ø.Ø)
      W=CMPLX(COS(PI/LE1),SIN(PI/LE1))
      DO 5 J=1,LE1
      DO 4 I=J,N,LE
      ID=I+LE1
      T=X(ID)*U
      X(ID)=X(I)-T
4     X(I)=X(I)+T
5     U=U*W
      RETURN
      END
      END$
```

```
*PUFT  T=00003 IS ON CR00002 USING 00002 BLKS R=0000

FTN4,L
      SUBROUTINE PUFT(Y,M,IWP)
      COMPLEX Y(512)
      N=2**M
      DO 1 I=1,N
 1    Y(I)=(0.0,0.0)
      IS=N/2-IWP/2+1
      IH=N/2+IWP/2
      DO 2 I=IS,IH
 2    Y(I)=(1.0,0.0)
      CALL CFFT(Y,M)
      RETURN
      END
      END$
```

```
*CIFT  T=00003 IS ON CR00002 USING 00003 BLKS R=0000

FTN4,L
      SUBROUTINE CIFT(X,M)
      COMPLEX X(1),U,W,T
      N=2**M
      B=1.0/N
      DO 6 J=1,N
 6    X(J)=B*X(J)
      N2=N/2
      N1=N-1
      J=1
      DO 3 I=1,N1
      IF(I .GE. J)GO TO 1
      T=X(J)
      X(J)=X(I)
      X(I)=T
 1    K=N2
 2    IF(K .GE. J)GO TO 3
      J=J-K
      K=K/2
      GO TO 2
 3    J=J+K
      PI=3.1415926
      DO 5 L=1,M
      LE=2**L
      LE1=LE/2
      U=(1.0,0.0)
      W=CMPLX(COS(PI/LE1),-SIN(PI/LE1))
      DO 5 J=1,LE1
      DO 4 I=J,N,LE
      ID=I+LE1
      T=X(ID)*U
      X(ID)=X(I)-T
 4    X(I)=X(I)+T
 5    U=U*W
      RETURN
      END
      END$
```

```
*PU     T=ØØØØ3 IS ON CRØØØØ2 USING ØØØØ2 BLKS R=ØØØØ

:TR,*RT
:LG,15
:MR,%MAIN
:MR,%ERTNN
:MR,%DUM
:MR,%PUTG
:MR,%NOYES
:MR,%PUAQ
:MR,%DFPK
:MR,%PSN
:MR,%PINT
:MR,%PSNA
:MR,%SYNØ
:MR,%RCVR
:MR,%FREQ
:MR,%RATØ
:MR,%PHAØ
:MR,%CNTØ
:MR,%FRQØ
:MR,%DLAY
:RU,LOADR,99,1,18,1,2
:RT,LOADR
```

```
*PUA    T=ØØØØ3 IS ON CRØØØØ2 USING ØØØØ1 BLKS R=ØØØØ

:TR,*RT
:LG,1Ø
:MR,%PUAN
:MR,%PUAN2
:MR,%DFUP
:MR,%PUFT
:MR,%CIFT
:MR,%CFFT
:RU,LOADR,99,1,18,Ø,2
:RT,LOADR
```

```
*PUA3   T=ØØØØ3 IS ON CRØØØØ2 USING ØØØØ1 BLKS R=ØØØØ

:TR,*RT
:LG,5
:MR,%PUAN3
:MR,%QPLOT
:MR,%ERAS
:RU,LOADR,99,1,18
:TR,*RT
```

```
:ST,B,%DFPK::-3:5
:ST,B,%PSN::-3:5
:ST,B,%PINT::-3:5
:ST,B,%PSNA::-3:5
:ST,B,%SYNØ::-3:5
:ST,B,%RCVR::-3:5
:ST,B,%FREQ::-3:5
:ST,B,%RATØ::-3:5
:ST,B,%PHAØ::-3:5
:ST,B,%CNTØ::-3:5
:ST,B,%FRQØ::-3:5
:ST,B,%DLAY::-3:5
:ST,B,%PUAN::-3:5
:ST,B,%PUAN1::-3:5
:ST,B,%DFUP::-3:5
:ST,B,%PUFT::-3:5
:ST,B,%CIFT::-3:5
:ST,B,%CFFT::-3:5
:ST,B,%QPLOT::-3:5
:ST,B,%ERAS::-3:5
```

```
#DTOT  T=00003 IS ON CR00002 USING 00002 BLKS R=0000

:ST,#PUTG,8
:ST,#PUAQ,8
:ST,#PUAN,8
:ST,#PUAN1,8
:ST,#PUAN2,8
:ST,#PUAN3,8
:ST,#PUFT,8
:ST,#CFFT,8
:ST,#CIFT,8
:ST,#PU,8
:ST,#PUA,8
:ST,#PUA3,8
:ST,#RT,8
:ST,%MAIN,8
:ST,%ERTNN,8
:ST,%DUM,8
:ST,%PUTG,8
:ST,%NOYES,8
:ST,%PUAQ,8
:ST,%DFPK,8
:ST,%PSN,8
:ST,%PINT,8
:ST,%PSNA,8
:ST,%SYN0,8
:ST,%RCVR,8
:ST,%FREQ,8
:ST,%RAT0,8
:ST,%PHA0,8
:ST,%CNT0,8
:ST,%FRQ0,8
:ST,%DLAY,8
:ST,%PUAN,8
:ST,%PUAN1,8
:ST,%DFUP,8
:ST,%PUFT,8
:ST,%CIFT,8
:ST,%CFFT,8
:ST,%QPLOT,8
:ST,%ERAS,8

#TTOD  T=00003 IS ON CR00002 USING 00002 BLKS R=0000

:ST,8,#PUTG::-3
:ST,8,#PUAQ::-3
:ST,8,#PUAN::-3
:ST,8,#PUAN1::-3
:ST,8,#PUAN2::-3
:ST,8,#PUAN3::-3
:ST,8,#PUFT::-3
:ST,8,#CFFT::-3
:ST,8,#CIFT::-3
:ST,8,#PU::-3
:ST,8,#PUA::-3
:ST,8,#PUA3::-3
:ST,8,#RT::-3
:ST,8,%MAIN::-3:5
:ST,8,%ERTNN::-3:5
:ST,8,%DUM::-3:5
:ST,8,%PUTG::-3:5
:ST,8,%NOYES::-3:5
:ST,8,%PUAQ::-3:5
```

MISSION

of

END

DATE
FILMED

1-82

DTIC